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(54) RELIABLE MESSAGE DELIVERY SYSTEM

VERLÄSSLICHES NACHRICHTENABLIEFERUNGSSYSTEM

SYSTEME FIABLE DE REMISE DE MESSAGES

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(73) Proprietor: **MOTOROLA, INC.**
Schaumburg, IL 60196 (US)

(72) Inventors:
- **KANE, John, Richard**
Wellington, FL 33414 (US)
- **SCHWENDEMAN, Robert, John**
Pompano Beach, FL 33060 (US)
- **WRIGHT, James, A.**
Coral Springs, FL 33065 (US)

(74) Representative: **Dunlop, Hugh Christopher et al**
Motorola,
European Intellectual Property Operations
Midpoint
Alencon Link
Basingstoke, Hampshire RG21 7PL (GB)

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Description

Field of the Invention

[0001] This invention relates generally to message delivery systems, such as for electronic mail systems, and more specifically to a method and apparatus for reliably delivering messages to one or more remote units from a central communication system utilizing a paging transmitter system.

Background of the Invention

[0002] Communication systems, such as paging systems, typically communicate messages from an originating device to one or more destination devices. These messages can include numeric and alphanumeric information for a user of the destination device. The destination device, e.g., a selective call receiver or pager, typically presents the information received to the user by displaying the information on a display.

[0003] Contemporary paging systems offer a limited message length for communicating information. For example, an alphanumeric message may be typically 80 characters or less. These typical message lengths have provided reasonably reliable delivery of messages to the users of the communication system.

[0004] On the other hand, a distinct trend in the market is for customers desiring much longer messages, such as from ten to one hundred times longer messages or more. Transmission of these messages over a paging channel can encounter a number of obstacles to reliable delivery of the longer messages, such as different types of interference, fading, noise, and other phenomena detracting from error-free and reliable communication of the messages to the destination devices.

[0005] This difficulty in reliable transmission of the longer messages is especially frustrating to customers that are used to communicating long messages over a more reliable communication medium, such as direct wire line or dial-up telephone communication. This is particularly the case for electronic mail system users which typically desire to send relatively long messages with a high degree of certainty that the messages are received error free. Typically, an originating device, such as a personal computer or workstation, can send long messages to one or more destination devices, such as other personal computers or workstations, over a direct wire line interface, or over a local area network (LAN), or over a dial-up telephone line connection using the public switched telephone network (PSTN).

[0006] WO91/01604 discloses a paging message interface and missed message retrieval system and method which enables the user of a display pager to determine whether any message out of a series of transmitted messages has been missed. The messages are numbered sequentially and are stored for retrieval at an originating clearing house in association with the user number and the message number. The message numbers are encoded in the message itself and are displayed to the user with the message. If a numbered message is missing from the sequence, the user can retrieve the message from the clearing house.

[0007] A need exists to enhance the reliability of transmitting messages, including long messages, in communication systems that utilize paging systems for delivering the messages.

Summary of the Invention

[0008] According to a first aspect of the invention, there is provided a method for reliably delivering messages in a communication system from a terminal to a selective call receiver as claimed in claim 1.

[0009] According to a second aspect of the invention, there is provided a communication system for reliably delivering messages fxom a central terminal to at least one communication receiver as claimed in claim 4.

[0010] According to a third aspect of the invention, there is provided a portable selective call receiver operable in cooperation with a communication system for reliably delivering messages from the communication system to the portable selective call receiver as claimed in claim 7.

Brief Description of the Drawings

[0011] FIG. 1 is a block diagram of a communication system in accordance with the preferred embodiment of the present invention.

[0012] FIG. 2 is a message block diagram illustrating a transmitted message according to the preferred embodiment of the present invention.

[0013] FIG. 3 is a message sequence diagram illustrating a first example of received messages being stored in the memory of a remote unit of the communication system according to the preferred embodiment of the present invention.

[0014] FIG. 4 is a message sequence diagram illustrating a second example of received messages being stored in the memory of a remote unit of the communication system according to the preferred embodiment of the present invention.

[0015] FIG. 5 is a block diagram illustrating messages stored in the memory of a central terminal of the communication system and messages stored in the memory of a remote unit before a reconciliation of messages between the central terminal and the remote unit, in accordance with the preferred embodiment of the present invention.

[0016] FIG. 6 is a flow diagram illustrating an operational sequence for a remote unit, according to the preferred embodiment of the present invention.

[0017] FIGs. 7 and 8 are message sequence diagrams illustrating a timing aspect of the second example of FIG. 4, in accordance with the preferred embodiment

of the present invention.

[0018] FIGs. 9 and 10 are flow diagrams illustrating operational sequences for the central terminal of FIG. 1, according to the preferred embodiment of the present invention.

[0019] FIGs. 11 and 12 are flow diagrams illustrating operational sequences for the remote unit of FIG. 1, according to the preferred embodiment of the present invention.

[0020] FIG. 13 is a message block diagram illustrating a transmitted message according to an alternative embodiment of the present invention.

[0021] FIG. 14 is a flow diagram illustrating an operational sequence for the central terminal of FIG. 1, according to the alternative embodiment of the present invention.

[0022] FIG. 15 is a flow diagram illustrating an operational sequence for the remote unit of FIG. 1, according to the alternative embodiment of the present invention.

Description of a Preferred Embodiment

[0023] FIG. 1 shows a communication system 100 utilizing a paging transmitter system 120, 122, 124, 126, for delivering messages to at least one portable remote unit, e.g., a portable selective call receiver 130, in accordance with the preferred embodiment of the present invention. A central terminal 102 comprises input sections 110, 112 for receiving inputs from a number of different devices 104, 106, 108, including receiving page requests for initiating pages that are transmitted by the paging transmitter system 120, 122, 124, 126, to the at least one portable remote unit 130. The central terminal 102 has input sections 110 that interface with the telephone company equipment, such as the public switched telephone network (PSTN) 107. Personal computers or other computing devices 104 can access the input sections 110 through the PSTN using a dial-up telephone line and modem communication. Other calling devices, such as telephone input devices 106 can access the input sections 110 of the central terminal 102 through the PSTN. Typically, these input devices 104, 106, can remotely initiate page requests through the central terminal 102 by calling up the input sections 110 of the central terminal 102 over dial-up telephone lines of the PSTN 107.

[0024] Alternatively, other input sections 112 of the central terminal 102 can receive inputs, such as page requests, from local computing devices 108, such as a local personal computer or console or other terminal device. Typically, the one or more local input devices 108 interface with the input sections 112 of the central terminal 102 via direct wire line connections using standard RS-232 or RS-422 interface.

[0025] The input sections 110, 112, communicate page requests to a controller 114 through a communication bus 116. The controller 114 may comprise controller circuitry and associated memory such that an incoming page request may be accepted and stored into available memory for subsequent transmission to one or more selective call receivers 130. Additionally, a non-volatile memory device 118, such as battery backed up RAM, one or more disc drive units, or other non-volatile storage medium, is utilized by the controller 114 for longer term storage of messages destined for the one or more selective call receivers 103. The controller 114 typically couples the message information and other associated information to the memory device 118 via the bus 116. The message information, which can include numeric, alphanumeric, or binary information, and other associated information stored in the memory 118 can be used by the controller 114 for reliable delivery of the message to the destination or remote unit 130, as will be more fully discussed below.

[0026] The controller 114 couples messages to the paging encoder 120 over the bus 116 for encoding the messages for transmission over a paging channel. The paging encoder 120 then couples the encoded messages over a communication path 122 to one or more paging transmitter systems 124, 126, for transmission over a paging communication channel. The communication path 122, in this example, will be labeled path B which routes the messages from the central terminal 102 to a paging transmitter system 124, 126, and over a paging communication channel for reception by the one or more selective call receivers 130. The general operation of a communication system including a paging system of the type shown in FIG. 1 is more fully described in U. S. Patent No, 5,138,311, issued August 11, 1992, entitled, "Communication system Having Adaptable Message Information Formats", which is assigned to the same assignee as the present invention.

[0027] The selective call receiver 130 preferably incorporates a paging receiver 134 that operates to receive messages transmitted over the paging communication channel through the antenna 132. The operation of a paging receiver 134 of the general type shown in FIG. 1 is well known and is more fully described in U. S. Patent No. 4,518,961 issued May 21, 1985, entitled, "Universal Paging Device With Power Conservation", which is assigned to the same assignee as the present invention.

[0028] The paging receiver 134 couples a received message to the controller 136 through the bus 138. The controller 136 operates to decode the received message, for matching address information in the received message to a predetermined address in the selective call receiver 130. In this way, the controller 136 can determine whether the received message is intended for the particular selective call receiver 130. Further, a memory 140 is coupled to the paging receiver 134 and the controller 136 through the bus 138 for storing the received message in the memory 140. A user can access user input means 141, such as buttons or switches, at the remote unit 130 to cause the message data of a received message to be displayed on a display, e.g., a

liquid crystal display (not shown). The user can then read the message that is visible on the display. User input at the remote unit 130 can also cause the remote unit 130 to perform other functions, such as may be well known to users of selective call receivers and portable personal computing devices.

[0029] A real time clock 142 is also coupled through the bus 138 to the controller 136 for providing time information thereto. The remote unit 130 is then capable of providing time information to the user as part of displaying information on the display (not shown). Additionally, the controller 136 can utilize the time information provided by the real time clock 142 to keep track of the time when messages were received at the remote unit 130, and other useful operations that will be more fully discussed below.

[0030] Furthermore, the selective call receiver 130 includes a modem transmitting unit and a modem receiving unit 144 and the associated telephone interfacing circuitry or other suitable communications apparatus (e. g., packet radio modem) which allows the user of the selective call receiver 130 to connect the selective call receiver to a telephone interface 150, such as may be provided by an RJ11 plug 148 and associated wiring 146 at the selective call receiver 130 and the complimentary wall jack 150 and associated wiring 152 thereof. This telephone interface 144, 146, 148, 150, 152, allows the controller 136 of the selective call receiver 130 to remotely access the central terminal 102 through a dial-up telephone line and the PSTN 107. At the central terminal 102, a modem transmitting unit and a modem receiving unit 111 is capable of communicating with the modem 144 at the selective call receiver 130. In this way, the selective call receiver 130 can communicate with the central terminal 102 and receive message information therefrom through a separate communication path which in this example is labeled path A 152. Therefore, the selective call receiver 130 can receive message information from the central terminal 102 via path A 152 and via path B 122. The path A 152 communication medium and the path B 122 communication medium can comprise any communication paths, such as direct wired line path, telephone line path, or wireless communication path including at least one radio communication channel, where preferably path A 152 is different than path B 122.

[0031] In the preferred embodiment, path A 152 is a dial-up telephone line using modem communication between the central terminal 102 and the remote unit 130. Also, preferably path B includes a paging communication channel for transmitting messages to the selective call receiver 130. Alternatively, path A may be a one-way or two-way radio frequency communication channel between the remote unit 130 and the central terminal 102, and path B can be a paging communication channel. Additionally, in another alternative, path A and path B can be one-way or two-way radio frequency communication channels. An advantage of delivering messages to the remote unit 130 through the paging communication channel over the two-way radio frequency communication channel is that typically more messages can be delivered through the medium in the paging communication channel. This in turn enhances the commercial viability of the communication system. However, using two-way radio frequency communication channels for both path A and path B may be perfectly acceptable in some systems.

[0032] By using a dial up telephone line interface for path A 152, and utilizing modem communication between the remote unit 130 and the central terminal 102 in the preferred embodiment, the reliability of transferring messages between the central terminal 102 and the remote unit 130 is relatively high and approaches the reliability that users of conventional computing systems are use to. Hence, it is advantageous to transfer messages over the dial-up telephone line interface 152 because it is a more reliable communication medium that transmission over the paging communication channel 122, e.g., over a radio paging channel. On the other hand, the dial-up telephone line interface 152 has the following draw backs. First, dial-up telephone line interfacing typically interfaces between one originating and one receiving device which significantly reduces the number of remote units that can subscribe to any type of communication system. Second, the telephone line interface 152 normally requires that the remote unit 130 connect to a telephone line interface which may not always be available. Third, the remote unit is not as portable due to the requirement that it be interconnected with the telephone interface. In the case of a paging communication channel transmission, the remote unit 130 is portable and can receive messages transmitted over the paging communication channel while the remote unit 130 is being carried on ones person. Hence, although the telephone line interface communication tends to be more reliable than the paging channel communication, it can significantly limit the number of subscribing remote units 130 in the communication system and it tends to inconvenience users by requiring them to connect their remote units 130 to a telephone line interface 152 for communication with the central terminal 102. Therefore, the preferred embodiment of the present invention utilizes both path A and path B communication of messages in a manner that significantly increases the reliability of transmission of messages between the central terminal 102 and the remote units 130 while allowing large numbers of portable remote units 130 to be serviced in the communication system as will be more fully discussed below.

[0033] The communication system 100 of the preferred embodiment of the present invention allows high throughput of messages between the central terminal 102 and the portable remote units 130 by transmitting messages over the path B 122, e.g., a radio frequency paging channel, for normal communication of new messages between the central terminal 102 and the remote

units 130. Additionally, for a higher grade of service, the central terminal 102 can transmit messages multiple times over path B 122 to better guarantee that the remote unit 130 will receive at least one of the transmissions of the same message. For example, the central terminal 102 can transmit a message three separate times over the paging channel 122 where each subsequent transmission of the same message is delayed by a predetermined time interval from the previous transmission, e.g., three minutes. In this way, the remote unit 130 has a higher probability of receiving the message transmitted over the paging channel 122.

[0034] Nonetheless, there may be times when the message is not received by the remote unit 130. In such event the communication system 100 provides a means at the remote unit 130 for determining that a message was missed and further for reconciling with the central terminal 102 to receive at least the message information of a missed message over a more reliable communication medium, such as provided through path A 152. However, the required throughput of path A 152 can be much lower than the throughput of messages through path B 122 because the number of missed messages will be much lower than the number of new transmitted messages for the communication system 100. Hence, the bulk of communication transmission including the transmission of new messages can be handled through path B 122, e.g., the radio frequency paging channel. And the reconciliation of missed messages between the remote units 130 and the central terminal 102 can be handled over the more reliable communication medium provided through path A 152, even though path A 152 can handle a lower throughput of message transmission. Further, the portable remote units 130 can be carried on ones person while receiving new message transmissions over the paging channel 122. The users of the remote units 130 will be minimally inconvenienced by requiring that the remote unit 130 be connected with the telephone line interface 152 to perform reconciliation of missed messages because messages typically will be missed on relatively infrequent occurrence. Optionally, as mentioned earlier, path A 152 can be configured as a one-way or two-way radio frequency communication channel between the central terminal 102 and the remote units 130. In this case, the message reconciliation can be performed while the users carry the remote selective call receivers 130 on their person. Hence, the users are minimally inconvenienced.

[0035] FIG. 2 is a message block diagram illustrating a transmitted message according to the preferred embodiment of the present invention. The transmitted message 200 typically includes identification and control information 202, as well as message data information 204. The message data 204 normally is the information that is communicated between an originating party and the destination remote unit 130. That is, the message data 204 is the message information communicated to the user of the selective call receiver 130. The message data 204 can include numeric information, alphanumeric information, and binary data. The identification and control information 202 included with the message 200 normally is required for delivering the message in the communication system 100. Such information 202 includes address information 206 which identifies one or more remote units 130 as the destination of that message data 204. Hence, when a remote unit 130 receives a message 200 that was transmitted from the central terminal 102 the remote unit 130 can determine whether that particular message 200 was intended for reception by the particular remote unit 130. Normally, the address information 206 included with the message 200 is decoded by the remote unit 130 and compared to a predetermined address in the remote unit 130. If the address information 206 in the message 200 matches the predetermined address in the remote unit 130 then the message 200 was intended for that particular remote unit 130. The remote unit 130 can then store the received message data 204 in a memory 140 in the remote unit 130, or optionally in a computer memory of a computing device associated with the remote unit 130 for later processing. A user of the remote unit 130 can subsequently review the message data 204 to communicate the message to the user. Typically, the user reviews the message on a display on the remote unit 130. That is, for example, the user can read the message on a display screen such as commonly available on portable personal computers and portable selective call display receivers.

[0036] Additionally, in the preferred embodiment of the present invention, the message 200 includes other identification information for enhancing the reliability of delivering the message from the central terminal 102 to the portable selective call receiver 130. For example, each message 200 can include a message sequence number 208 which identifies the relative sequence of the message 200 in a transmission sequence for messages transmitted from the central terminal 102 to the remote unit 130 for a particular address information 206. That is, each message that includes the same address information 206, i.e., that is destined for reception by the same one or more remote units 130, can be tagged with a message sequence number 208 that identifies to the one or more remote units 130 when a transmitted message 200 is received out of sequence or when a transmitted message was not received by the remote unit 130.

[0037] When a transmitted message 200 is received by the remote unit 130, and the address information 206 in the message 200 matches a predetermined address for the remote unit 130, then if the message sequence number 208 identifies the message 200 as being out of sequence with a transmission sequence established by previously received messages, then the remote unit 130 may determine that one or more messages were transmitted by the central terminal 102 and not received by the remote unit 130. Those transmitted messages that

intervened between the last received message in the transmission sequence and the received message being out of sequence may have been missed by the remote unit 130. However, the intervening messages may not always have been missed.

[0038] For example, the communication system 100, as discussed earlier, can transmit messages multiple times over the paging communication channel 122 to provide a higher grade of service for the destination remote units 130. In this case, a message 200 can be received by the remote unit 130 and the message sequence number 208 may indicate that the received message 200 is out of sequence with a transmission sequence established by previously received messages at the remote unit 130. However, this may only indicate that one transmission of a message was missed by the remote unit 130 and that subsequent re-transmissions of that message may be received by the remote unit 130 thereby reestablishing the transmission sequence of received messages at the remote unit 130.

[0039] Preferably, a message repetition count 210 is included with each transmitted message 200 to identify to a receiving remote unit 130 the relative position of the received message 200 in a repetition sequence. For example, if, under a grade of service, messages are repeatedly transmitted three times for delivery to a receiving remote unit 130, where the repeatedly transmitted messages have the same destination address 206, then a received message 200 including a message repetition count 210 of two may identify to the receiving remote unit 130 that the received message 200 was the second transmission of that message from the central terminal 102.

[0040] Other information can be transmitted with a transmitted message 200, such as error detecting and/or correcting code. For example, a cyclic redundancy code (CRC) 212 can be included with each transmitted message 200 to help identify at the receiving remote unit 130 when received message data 204 has been erroneously received. That is, the message data 204 has been received with errors included therein. In this case, although the message 200 has been received by the remote unit 130, the message data 204 may not be completely and correctly communicated to the user of the remote unit 130. Hence, the remote unit 130 has failed to receive the message 200, as required to communicate the message information to the user of the remote unit 130. Hence, two possible conditions can identify when the remote unit 130 has failed to receive a transmitted message. The first is when the remote unit receives a transmitted message out of sequence with a previously established transmission sequence. The second is when the remote unit 130 receives a transmitted message having errors in the message data 204. The CRC 212 can be used by the receiving remote unit 130 to determine when the received message includes errors in the received message data 204. Therefore, a receiving remote unit 130 has at least these two ways of affirmatively determining that a transmitted message was not received by the remote unit 130.

[0041] FIG. 3 is a message sequence diagram illustrating messages being received by a remote unit 130 and being stored in memory 140 for identifying a transmission sequence as established by the previously received messages. For example, a transmitted message 200 included a message sequence number 208 identifying the received message 200 at the remote unit 130 as being the first received message in a transmission sequence. This is shown in FIG. 3 by the message block 302 including the number 1 to identify the message as the first in a transmission sequence. That message 302 was received by the remote unit 130 and stored in the memory 140. Subsequently, a second message 304 in the transmission sequence was received by the remote unit 130 and stored in memory 140. The remote unit 130 may store additional information with each message in memory 140 to identify the transmission sequence as shown. For example, the messages 302, 304, may be stored in a linked list data structure in memory 140. In this way, the controller 136 can keep track of a transmission sequence as identified by the previously received messages 302, 304. When a new message is received, such as shown by message number three 306 the controller 136 can couple the message 306 to the memory 140 and organize the message 306 into the link list of previously received messages 302, 304, for a particular address. The sequence is shown by the messages 308, 310, 312, organized into the link list.

[0042] FIG. 4 illustrates a second example of received messages being stored in the memory 140. A linked list of messages 402, 404, 406, 408 can indicate to the remote unit 130 that received messages four 406 and five 408 were received out of sequence with a previously established transmission sequence. In other words, message three was missed by the remote unit 130. If the communication system 100 repeatedly transmits each transmitted message over the paging communication channel, then a subsequent transmission of message three 410 may be received by the remote unit 130. Consequently, the linked list of messages in memory 140 can be adjusted to reestablish a transmission sequence as indicated by previously received messages 412, 414, 416, 418, 420. In this example, messages four 406 and five 408 were received by the remote unit 130 between the time that a first transmission of message three was missed by the remote unit 130 and a second transmission of message three 410 was received by the remote unit 130. As mentioned earlier, re-transmissions of the same message can occur every several minutes to enhance the probability that the remote unit 130 will receive at least one of the transmissions. Of course, subsequent receptions of an already received message are simply ignored. In this way, the communication system 100 can enhance the reliability of delivering messages from the central terminal 102 to one or more remote units 130.

[0043] Additionally, when the communications system 100 retransmits messages to the one or more remote units 130 to provide a higher grade of service, the remote unit 130 can delay a predetermined time interval after receiving the latest message in the transmission sequence before determining that any subsequently received messages were received out of sequence. That is, the remote unit 130 can delay a predetermined amount of time to avoid falsely indicating to a user of the remote unit 130 that a message was missed by the remote unit 130 during a time interval where the missed message may be re-transmitted by the central terminal 102 and received by the remote unit 130.

[0044] For example, the remote unit 130 can delay ten minutes after receiving message number two 404, and if message number three is missed during that ten minute time interval while message numbers four and five 406, 408, are received during that ten minute time interval the remote unit 130 does not disturb the user by indicating that message number three was missed. If message number three 410 is also received during that ten minute time interval then the remote unit 130 can reestablish the transmission sequence as indicated by the linked list of messages 412, 414, 416, 418, 420, that are stored in memory 140. Hence, in one mode of operation, after receiving a message that is determined to be in the transmission sequence established by previously received messages, the remote unit 130 can provide a time window, i.e., a predetermined time interval, where message repetition after a missed message may reestablish a transmission sequence as stored in the memory 140 of the remote unit 130. Further, the user is not bothered by unnecessary alerts indicating that a message was not received by the remote unit 130. This process can be handled automatically by the remote unit 130 relieving the user from having to keep track of the received message sequence.

[0045] FIG. 5 is a block diagram illustrating a sequence of messages stored in the memory 118 of the central terminal 102 as the messages have been transmitted from the central terminal 102 to the remote unit 130. Further, the memory 140 of the remote unit 130 is shown including the messages received by the remote unit 130. The messages can be stored in both memories 118, 140, to indicate a transmission sequence through the message sequence numbers 208, and to indicate a repetition sequence through the message repetition count 210. Hence, the central terminal 102 and the remote unit 130 can individually keep track of a message transmission sequence. As shown, messages three, four and five were transmitted from the central terminal 102 but only messages four and five were received by the remote unit 130. The first transmission of message three, as shown by the message sequence number 502 and the message repetition count 504 stored in the memory 118 of the central terminal 102 has been missed by the remote unit 130. The memory 140 of the remote unit 130 shows that messages one, two, four and five were received by the remote unit 130, where messages four and five were received out of sequence with the transmission sequence established by the previously received messages one and two. Hence, message three was missed by the remote unit 130. One way that message three can be reliably delivered to the remote unit 130 is through message repetition, as discussed earlier. Hence, the next time that message number three is transmitted to the remote unit 130 it may be received by the remote unit 130. A second way that message number three can be reliably delivered to the remote unit 130 is through message reconciliation. This is indicated by the arrow 506. In this case, the remote unit 130 communicates with the central terminal 102 via the path A 152 to deliver message number three to the remote unit 130. That is, the remote unit 130 and the central terminal 102 reconcile the transmitted messages against the received messages 506 and only those messages that were missed by the remote unit 130 need be transmitted over path A. Therefore, the message throughput over path A 152 can be kept to a minimum which reduces the amount of time spent communicating between the remote unit 130 and the central terminal 102 over path A 152, and consequently allows more remote units 130 to efficiently communicate with the central terminal 102 over path A 152 with the available resources of the central terminal 102. This is a significant advantage of the present invention. The reconciliation process 506 will be more fully discussed below.

[0046] FIG. 6 is a flow diagram illustrating an operational sequence for the remote unit 130, according to the preferred embodiment of the present invention. A communication system 100 can optionally transmit messages multiple times to enhance the probability that at least one of the transmissions will be received by a portable unit 130 as discussed earlier. The portable unit 130, in this case, preferably delays a predetermined time from the last message received before determining that the received message is out of sequence with a transmission sequence previously established. One approach, as discussed earlier, was to delay a predetermined time interval after a received message was determined in sequence with the previously established transmission sequence. For example, a ten minute window would be allowed after the last received message in a transmission sequence for receiving other messages that may or may not be in sequence with the transmission sequence. After the ten minute delay the remote unit 130 would determine whether any received messages subsequent to the last received message in the transmission sequence were out of sequence and alert the user accordingly. In a second preferred approach, as illustrated in FIG. 6, the remote unit 130 delays a predetermined time interval, e.g., a ten minute time interval, after each received message before determining that the received message is out of sequence with the transmission sequence established by previously received messages. That is, before determining that one or more

messages may have been missed between the last received message and the previously established transmission sequence.

[0047] Specifically, FIG. 6 illustrates an operational sequence for the remote unit 130 which may be executed periodically in an event driven system. Every time that a message is received 602, 604 the remote unit 130 stores the message and starts a timer 606 to time a predetermined time interval after receiving the message. Each received message has associated a timer for timing out the respective time window after reception of the message. Each timer can be represented by a data structure in memory 140. If any timer times out 608 then the remote unit 130 reviews the linked list of messages in memory 140 to determine if any messages are missing with respect to the previously established transmission sequence 610. That is, the remote unit 130 for example, can traverse the linked list from the beginning to the point where the message having the timer has timed out to determine if there are any messages missing in the transmission sequence.

Further, any missing messages would be flagged 612 to indicate the missed message condition. Optionally, at this time, the remote unit 130 can alert the user that a previously transmitted message was missed. The user can then couple the remote unit 130 to a telephone interface and utilize path A 152 communication with the central terminal 102 to reconcile and receive from the central terminal 102 at least the message data of a previously missed message.

[0048] FIGs. 7 and 8 illustrate the preferred timing aspect as discussed above, using the message sequence of the second example illustrated in FIG. 4. As shown, the remote unit 130 receives messages 702, 704, 706, 710, and stores them in a linked list in memory 140 where the first two messages established a transmission sequence 703, 705, and the subsequent two messages 706, 710, were received out of sequence with the previously established transmission sequence 703, 705, and have independent timers for each of the messages 708, 712, timing predetermined time intervals after reception of each of the messages respectively to determine if there were any missed messages between the transmission sequence 703, 705 and the subsequently received messages 706, 710.

[0049] FIG. 8 illustrates message three 802 having been received by the remote unit 130 and the timer for message four 706 having timed out a predetermined time interval. Consequently, the transmission sequence 702, 704, 706, spans to message four 804 as established by the received messages one 703, two 705, three 802, and four 804. Message five's timer 712 continues to time out its predetermined time interval before determining whether a message was missed prior to receiving message five 710. When message five's timer 712 eventually times out the transmission sequence will include all five received messages 702, 704, 706, 710.

[0050] FIGs. 9 and 10 are flow diagrams illustrating operational sequences for the central terminal 102, according to the preferred embodiment of the present invention. As the central terminal 102 receives requests to transmit new messages 902 to one or more remote units 130, the central terminal 102 determines whether a transmission to a plurality of remote units of 130 is requested, that is the message destined for a group 904 of remote units 130, if it is not, the central terminal 102 verifies 906 whether the remote unit 130 can be reached through the more reliable path A 152. This may be the case that the remote unit 130 is currently coupled to the central terminal 102 via path A 152 and receive the message data through the more reliable communication medium. Another aspect of the reliable communication through path A 152 is that the remote unit 130 can acknowledge affirmative reception of the message data from the central unit 102, and hence the central terminal 102 optionally can retransmit the message through path A 152 when the remote unit 130 failed to receive the message from the central terminal 102 over path A 152.

[0051] If the remote unit 130 is not reachable 906 through path A 152, then the central terminal 102 increments 908 the message counter for the address of the message for transmission through path B 122, and then sends 912 the message over path B 122. The message includes the message sequence identifier and the CRC code for error detection at the remote unit 130. The central unit 102 then determines 914 whether the remote unit 130 can and has acknowledged reception of the transmitted message. And in the case where the message is transmitted through path B 122, e.g., through the paging communication channel, no acknowledgment is expected by the central terminal 102, and the central terminal 102 then stores 918 the message in the memory 118.

[0052] When the central terminal 102 receives a request to transmit a message to a single remote unit 902, 904, 906, and the remote unit 130 is currently connected to the central terminal 102 through path A 152, then the central terminal 102 increments 910 the message counter for the address for transmission through path A 152, and sends 912 the message, including the message sequence identifier and the CRC over the path A 152 using the more reliable communication medium. In this case, the remote unit 130 is expected to acknowledge 914 the reception of the transmitted message, and on so doing the central terminal 102 can optionally discard the message from memory 118 or save the message information in a history file 916 for future reference.

[0053] FIG. 10 illustrates the central terminal 102 operating in a reconciliation sequence with a remote unit 130 over path A 152 according to the preferred embodiment of the present invention. When the central terminal 102 detects 1002 that a remote unit 130 is connected to the central terminal 102 through path A 152, and the remote unit 130 is requesting a reconciliation operation then the central terminal 102 checks 1004 in the memory 118 for messages transmitted to the remote unit 130

including address information matching a predetermined address for the remote unit 130. The particular address, or addresses, to reconcile messages with the remote unit 130 can be identified in the request by the remote unit 130.

[0054] The central terminal 102 searches 1006 the messages in memory 118 that were transmitted to the remote unit 130 and not acknowledged by the remote unit 130 as having been received. Preferably, in the reconciliation request the remote unit 130 also identifies the messages that were received by the remote unit 130 since the last time the remote unit 130 requested reconciliation with the central terminal 102. Hence, the central terminal 102 verifies 1010 each of the messages identified in the reconciliation request, e.g., identified by the message sequence number, as having been transmitted by the central terminal 102 and received by the remote unit 130. If the transmitted message was a group message 1012 then the central terminal 102 flags the message in memory 140 as having been received by one remote unit 130 that is a member of a group.

[0055] Subsequently, the central terminal 102 continues searching 1006 for any other messages in memory 118 that were transmitted to the remote unit 130. If the identified message was not a member of a group 1012 then after a confirmation from the remote unit 130 the central terminal 102 can delete 1014 the message from the memory 118, or optionally store the message in a separate history file, and then continue searching 1006 for other messages in memory 118 that were transmitted to the remote unit 130. If the reconciliation request identifies that the remote unit 130 failed to receive a transmitted message, then the central terminal 102 transmits 1018 at least the message data of the missed message to the remote unit 130 through path A 152, and the central terminal 102 waits a predetermined time interval for an acknowledgment 1020 from the remote unit 130. Upon receiving an acknowledgment 1020, the central terminal 102 then determines whether the transmitted message was destined for a group 1012 of remote units 130, and, if it was, then the central terminal 102 flags 1016 the message in memory 118 as having been received by the individual remote unit 130, and continues searching 1006 for other messages in memory 118. On the other hand, if the transmitted message was not destined for a group 1012 then the central terminal 102 can delete 1014 the message from memory 118. Subsequently, the central terminal 102 continues searching 1006 for other messages in memory 118.

[0056] Optionally, if the central terminal 102 receives a negative acknowledgment 1022, or after a predetermined time interval after transmitting a message over path A, then the central terminal 102 checks if this is the third time 1022 that the message was not acknowledged by the remote unit 130, and re-transmits the message 1018 up until the third time of no acknowledgment 1020, 1022. On a third try 1022, the central terminal 102 terminates the current communication over path A, and begins monitoring 1002 for a remote unit 130 requesting reconciliation over path A 152. In this way, the central terminal 102 can reliably deliver the message information to the remote unit 130 over path A by repeatedly transmitting the message information until the central terminal 102 receives an affirmative acknowledgment from the remote unit 130.

[0057] As discussed earlier, path A 152 may include a one-way or two-way radio frequency communication channel for transmitting the message information to the remote unit 130 and receiving an affirmative acknowledgment over reception therefrom. This acknowledgment operation between a central terminal 102 and a remote unit 130 is more fully described in U. S. Patent No. 4,918,437, issued April 17, 1990, entitled "High Data Rate Simulcast Communication System", and in U. S. Patent No. 4,882,579, issued November 21; 1989, entitled "Code Division Multiplexed Acknowledge Back Paging System", and further in U. S. Patent No. 4,875,038, issued October 17, 1989, entitled "Frequency Division Multiplexed Acknowledge Back Paging System", all of which are assigned to the same assignee as the present invention

[0058] FIGs. 11 and 12 are flow diagrams illustrating operational sequences for the remote unit 130, according to the preferred embodiment of the present invention. FIG. 11 illustrates an exemplary message reception routine, and FIG. 12 illustrates an exemplary reconciliation handling routine or update routine. Typically, the remote unit 130 monitors 1102 whether a transmitted message was received by the remote unit 130, and waits 1116 for a message to be received. When a message is received 1102 the remote unit 130 checks 1104 if the message is a new message, and if not, then the remote unit 130 marks the message in memory 140 as having been a duplicate received message 1108. The remote unit 130 then may continue other operations while monitoring 1102 for other messages being received.

[0059] If a new message is received 1104 then the remote unit 130 stores 1106 the message in memory 140 and verifies 1110 that the message data contains no errors. This can be done by using the CRC transmitted with the message. If the message was received with no errors in the message data 1110 then the remote unit 130 can flag 1118 the message, including the message sequence number and other identifying information, in memory 140. If the message was received over path B 1120, and not path A, then the remote unit 130 continues waiting 1116 and monitoring 1102 for messages being received. On the other hand, if the message was received 1120 over path A, then the remote unit 130 sends a message acknowledgment 1122 to the central terminal 102 over path A. Further, if the message was received as part of a reconciliation sequence 1124, then the remote unit continues the operational sequence in the reconciliation routine 1128. Otherwise, the remote unit 130, continues waiting 1116 and monitoring 1102

for other received messages.

[0060] If the message was received with errors 1110 in the message data, then the remote unit 130 determines whether the message was received over path A 1112. If received over path A 1112, then the remote unit 130 sends a negative acknowledgment message 1126 to the central terminal 102 to request re-transmission of the message. Subsequently, the remote unit may return to the reconciliation routine 1124, 1128 or may continue waiting 1116 and monitoring 1102 for other received messages. Alternatively, if the message with errors in the message data was received over path B 1112, and not path A, then the remote unit flags 1114 the message information in memory 140 as having failed to receive the message correctly. Subsequently, the remote unit 130 continues waiting 1116 and monitoring 1102 for messages received. In this way, the remote unit 130 keeps in memory 140 an account of messages received in a transmission sequence, of messages received with errors in the message data, and of messages that were not received by the remote unit 130.

[0061] Referring to FIG. 12, once the remote unit 130 is connected 1201 and communicating with the central terminal 102 over path A 152, the remote unit 130 can initiate a reconciliation sequence 1202 with the central terminal 102. This can be done automatically between the remote unit 130 and the central terminal 102, or, optionally, in a response to a manual entry, e.g., in response to user input, at the remote unit 130. For example, via buttons or switches 141 at the remote unit 130. While in the reconciliation handling routine 1202, if the remote unit 130 receives a request from the central terminal 102 to terminate 1204 the reconciliation sequence the remote unit 130 can exit the reconciliation handling routine and go and perform 1206 other functions. While in the reconciliation routine, the remote unit 130 waits to receive 1208 a transmission over path A from the central terminal. If the received message information 1208 is not correctly received by the remote unit 130, the remote unit 130 can request reconciliation again 1210, 1202. If the remote unit 130 requests reconciliation for a third time 1210 then it notifies 1212 the user that there is an error in communication with the central terminal 102.

[0062] In this example, as part of the response to the reconciliation request by the remote unit 130, the central terminal 102 can indicate the message sequence identifiers that the central terminal 102 is prepared to transmit to the remote unit 130. If the remote unit 130 determines 1214 that the message, as identified by the message sequence number indicated by the communication from the central terminal 102, was previously received by the remote unit 130, then the remote unit 130 can immediately transmit an acknowledgment 1216 to the central terminal 102 to let the central terminal 102 know that the message data does not have to be transmitted. Additionally, the remote unit 130 can determine 1280 if the message data was previously deleted from memory 140, such as after a user has read the message from a display. In this case, the remote unit 130 can also delete 1220 the message, message sequence number, and other associated information from memory 140 and then continue with the reconciliation request 1202.

[0063] If the remote unit 130 determines 1214 that a message was not received, or that the message data included errors, then the remote unit 130 can acknowledge 1222 to the central terminal 102 that the remote unit 130 failed to receive the particular message. In this case, the remote unit 130 waits 1224 for a predetermined time interval for the central terminal 102 to transmit at least the message data corresponding to the message that was missed over path A 152. If not received by the remote unit 130 within the predetermined time interval, then the remote unit 130 negatively acknowledges 1226 the central terminal 102, thereby requesting a re-transmission. Once the remote unit 130 receives 1224 at least the message data within the predetermined time interval, the remote unit 130 can then go perform the message reception routine 1130, as shown in FIG. 11 and previously discussed. In this way, the remote unit 130 operates to receive at least the message data of previously missed messages that were identified through the reconciliation request.

[0064] Thus, the communication system 100 discussed above can provide the advantages of a high throughput and reliable delivery of messages between a central terminal 102 and one or more remote units 130. By utilizing a first communication medium, such as the paging communication channel, for the high throughput delivery of messages, and then utilizing a second communication medium, such as a more reliable dial-up telephone line interface between the central terminal 102 and the remote unit 130, the communication system 100 can effectively service large numbers of users, thereby making the communication system 100 commercially viable. At the same time, the reliability of message delivery approaches that of the direct wire line or dial-up telephone line interface, which users are becoming use to. Further, users are able to roam freely without being tied down to a specific geographic location, as limited by conventional wire line and dial-up telephone line communication systems. This is a significant advantage of the preferred embodiment of the present invention.

[0065] Furthermore, other communication techniques may be used by the communication system 100 to enhance reliability of delivering messages from the central terminal 102 to the one or more remote units 130. For example, a fade resistant coding scheme may be used in encoding the messages that are transmitted over the paging channel.

This technique can significantly reduce the probability that messages will be corrupted or missed by the receiving remote units 130 due to fading phenomena. A communication system providing fading resistant message coding, such as mentioned above, is more fully described in U. S. Patent No. 4,914,649, issued April 3,

1990, entitled "Multiple Frequency Message System", which is assigned to the same assignee as the present invention.

[0066] Additionally, another technique for enhancing the reliability of delivering messages over the.paging channel includes message compression. By reducing the total amount of time that a message requires for transmission over the paging channel, this reduces the probability that the message will be corrupted by noise, interference, fading, or other obstacles to communication. There are commercially available message compression algorithms that may be used at the central terminal 102 and at the remote units 130.

[0067] In an alternative embodiment of the present invention, the communication system 100 can deliver messages from the central terminal 102 to a plurality of remote units 130 without utilizing a message sequence number 208 in a message 200. Consequently, the central terminal 102 can simplify the data structure stored in memory 118 for each address of the plurality of remote units 130 in the communication system 100. Each address can have defined a portion of memory 118 for storing the messages that were transmitted to that address in the communication system 100. The messages do not have to be organized in memory 118 to represent a transmission sequence for the particular address, such as in a linked list structure. Of course, the central terminal 102 can optionally maintain message organization, e.g., the linked list, representing a transmission sequence. But it is not required, thereby allowing a simpler data structure to be maintained in memory 118.

[0068] Also, the message sequence number 208 is preferably not included in the message 200 that is transmitted to the one or more remote units 130. This reduces the transmission overhead for transmitted messages over the paging communication channel 122. Hence, it increases the overall channel throughput.

[0069] Furthermore, the remote unit 130 can store a simpler data structure in its memory 140, by not representing a transmission sequence with a data structure such as a linked list maintained in the memory 140. This allows simpler operation at the remote unit 130 because the transmission sequence information may not necessarily be maintained at the remote unit 130. Of course, if so desired, the remote unit 130 can maintain a data structure in memory to represent a transmission sequence, such as if the message sequence numbers are included with the messages transmitted to the remote unit 130.

[0070] Finally, the message reconciliation process between the remote units 130 and the central terminal 102 over path A 152 can also be simplified without including the message sequence numbers during message reconciliation communication over path A 152, as will be more fully discussed below. This can also enhance the overall throughput of delivering messages over path A 152. Therefore, in this alternative embodiment of the present invention which is more fully discussed below, the communication system 100 can deliver messages from the central terminal 102 to the one or more remote units 130 without including the message sequence numbers 208, thereby providing a simpler message organization in the central terminal memory 118 and the remote unit memory 140, as well as reducing the overhead of information being transmitted for every message which can enhance the overall communication channel throughput (both over path A 152 and over path B 122).

[0071] FIG. 13 is a message block diagram illustrating a transmitted message 1300 according to the alternative embodiment of the present invention. The central terminal 102 transmits the message 1300 to the one or more remote units 130 typically over the paging communication channel (path B) 122. The transmitted message 1300 typically includes identification and control information 1302, as well as message data information 1304. The message data 1304 normally is the information that is communicated between an originating party and the destination remote unit 130. That is, the message data 1304 is the message information communicated to the user of the selective call receiver 130. The message data 1304 can include numeric information, alphanumeric information, and binary data. The binary data is preferably word level compatible with computer systems, such as 8 bit binary data for personal computers.

[0072] The overhead information 1302 included with a message 1300 normally is required for delivering the message 1300 in the communication system 100. Such overhead information 1302 normally includes address information 1306 which identifies one or more remote units 130 as the destination of the associated message data 1304. Typically, when a remote unit 130 receives a message 1300 that was transmitted from the central terminal 102 the remote unit 130 can determine whether the particular message 1300 was intended for reception by the particular remote unit 130 by comparing the address information 1306 associated with the message 1300 to a predetermined address for the remote unit 130. A match between the address information 1306 and the predetermined address indicates that the particular remote unit 130 is the destination of the received message 1300.

[0073] A message identifier 1308 provides a means for identifying a message sent with the address information 1306 for reception by one or more remote communication receivers 130. The message identifier 1308 may comprise any identifying code, e.g., including any combination of numeric or non-numeric symbols, that can distinguish a message apart from other messages having the same address information 1306. This message identifier 1308 is useful where multiple messages are sent in the communication system 100 including one address information therewith, to allow the central terminal 102 and the remote units 130 to identify the multiple messages by the message identifiers included therewith.

[0074] Preferably, a CRC error detection code 1308 in the message 1300 provides a means for the remote unit 130 to determine when the received message data 1304 has been erroneously received, as discussed earlier, and, the CRC 1308 can also provide a means of identifying a received message 1300 for a particular address information 1306 because normally the CRC 1308 varies with the contents of the message data 1304. Both at the central terminal 102 and at the receiving remote units 130 the message 1300 can be stored along with the CRC 1308 for the particular address 1306 to help identify transmitted and received messages during the reconciliation process, as will be more fully discussed below. Also, other identification and control information 1310, such as a message repetition count or even message sequence numbers, may be included in the message overhead 1302.

[0075] Normally when the central terminal 102 sends the message 1300 over the paging communication channel (path B) 122, the central terminal 102 stores a copy of the message 1300 including the CRC 1308 in the memory 118. The central terminal 102 maintains a database in the memory 118 for keeping track of the messages sent to each address in the communication system 100. For example, a database file in the memory 118 can group all the messages sent to an address (associated with one or more remote units 130) since the last time the central terminal 102 reconciled messages with the one or more remote units 130 associated with the address.

[0076] When the remote unit 130 receives the message 1300, the remote unit 130 stores at least the message data 1304 and the CRC 1308 of the message 1300 in the memory 140. The remote unit 130 keeps track of the received messages for each address, for example, using a database in the memory 140. The CRC 1308 of the received message 1300 can be used by the remote unit 130 to verify the message data 1304 to determine whether it was erroneously received. Optionally, when the remote unit determines that the message data 1304 was erroneously received, the remote unit 130 can alert the user of the error condition. That is, as an example, when the message data 1304 is determined corrupted by the receiving remote unit 130, the remote unit 130 can automatically alert the user via a message on a visual display. The user can then couple the remote unit 130 to a telephone interface and utilize path A 152 communication with the central terminal 102 to request reconciliation of transmitted messages. In the reconciliation process the remote unit 130 can receive from the central terminal 102 at least the message data of the previously missed message, as further illustrated below.

[0077] FIGS. 14 and 15 are flow diagrams illustrating operational sequences for the communication system 100, in accordance with the alternative embodiment of the present invention. FIG. 14 illustrates a reconciliation sequence for the central terminal 102, according to the alternative embodiment of the present invention. FIG. 15 illustrates a reconciliation sequence for the remote unit 130, according to the alternative embodiment of the present invention.

The two operational sequences shown in FIGS. 14 and 15 may operate in a reconciliation process between the remote unit 130 and the central terminal 102 being coupled over the more reliable communication medium of path A 152, such as a dial up telephone line over the PSTN. The remote unit 130 can communicate through path A 152 with the central terminal 102 to initiate a reconciliation request and receive at least the message data 1304 of messages 1300 that were previously missed by the remote unit 130.

[0078] Referring to FIG. 14, while no reconciliation request is received 1402, 1404, by the central terminal 102, the central terminal 102 may wait 1406 for the reconciliation request and perform other system functions as necessary. When the central terminal 102 receives 1404 a reconciliation request from a remote unit 130 that is currently communicating with the central terminal 102 through path A 152, the central terminal 102 checks 1408 the database in the memory 118 associated with an address corresponding to the remote unit 130 for any previously transmitted messages. The address typically is identified in the reconciliation request. In the reconciliation operation, for example, the central terminal 102 can verify 1410, 1414 the messages stored in the database one at a time (identified by their CRC) with the remote unit 130 to determine whether there are any messages that were previously sent including the particular address of the database in memory 118 and that were not acknowledged as having been received by the remote unit 130.

[0079] Once the central terminal 102 determines 1408 that there are previously transmitted messages in the database in the memory 118, the central terminal 102 searches 1410 the messages in memory 118 that were transmitted to the remote unit 130 and not acknowledged by the remote unit 130 as having been received. Preferably, in the reconciliation request the remote unit 130 identifies at least one address corresponding to the remote unit 130, and the central terminal 102 can then search 1410 all messages that were transmitted to that address that are stored in the database in the memory 118. If there are 1410 no messages in the database that remain unacknowledged by the remote unit 130 then the central terminal 102 can send 1412 an "end of update" message through path A 152 to the remote unit 130, signaling the end of the reconciliation sequence for that address. On the other hand, if there are 1410 messages that were not acknowledged by the remote unit 130, then the central terminal 102 can identify each of these messages to the remote unit by sending the particular CRC of the message over path A 152 to the remote unit 130 and then verifying 1414 a response from the remote unit 130 identifying the reception status of the message corresponding to the particular CRC for the address.

[0080] If the remote unit 130 responds 1414 by acknowledging the message corresponding to the particular CRC as being marked "good" then the central terminal 102 knows that the message was completely and correctly received by the remote unit 130 and then can delete 1416 the message from the database in the memory 118. Subsequently, the central terminal 102 can process 1410 another message in the database. The central terminal 102 can send to the remote unit 130 through path A 152 the CRC of the next message being processed to verify 1414 whether the message was received by the remote unit 130.

[0081] If the remote unit 130 acknowledges 1414 the CRC of the message as having been marked "bad", e.g., indicating that the previously transmitted message was missed by the remote unit 130, then the central terminal 102 can send 1418 at least the message data 1304 to the remote unit 130 over path A 152. The central terminal 102 then waits 1420 for an acknowledgment from the remote unit 130. If the central terminal 102 receives a negative acknowledgment, e.g., a NACK control message, from the remote unit 130 then the central terminal 102 will resend 1418 at least the message data 1304. But if the central terminal 102 has already resent to the remote unit 130 for a predetermined number of times, e.g., for a third time 1422, it then may terminate the reconciliation session. Hence, the central terminal 102 can retransmit the at least message data 1304 to the remote unit 130 over the more reliable path A 152, for example, for up to three times. After the third try 1422 the central terminal 102 may discontinue the communication with the remote unit 130 and free up the interface to connect 1404 with other remote units 130.

[0082] When the message is acknowledged 1420 by the remote unit 130 the central terminal 102 can then delete 1416 the message from the database in the memory 118, and then go and process 1410 any other messages in the database that have not been acknowledged by the remote unit 130. This handshaking process between the central terminal 102 and the remote unit 130 can continue until all the messages in the database have been processed. In this way, the central terminal 102 can deliver at least the message data 1304 of messages 1300 to the remote unit 130 over the more reliable medium of the path A 152. Hence, if the remote unit 130 previously missed a message 1300 over path B 122, the remote unit 130 can subsequently reconcile with the central terminal 102 over path A 152 and reliably receive at least the message data 1304 of the previously missed messages 1300. When all messages have been processed, the central terminal 102 can send 1412 an "end of update" message over path A 152 to the remote unit 130 to end the reconciliation process.

[0083] Referring to FIG. 15, once the remote unit 130 is connected 1502, 1504 and communicating with the central terminal 102 over path A 152, the remote unit 130 can initiate a reconciliation sequence 1506 by sending a reconciliation request to the central terminal 102. This can be done automatically between the remote unit 130 and the central terminal 102, or, optionally, as a response to a manually entry, e.g., in response to user input, at the remote unit 130. For example, via buttons or switches 141 at the remote unit 130. While in the reconciliation sequence, if the remote unit 130 receives a request from the central terminal 102 to terminate 1508 the reconciliation sequence the remote unit 130 can exit 1510 and go and perform other functions as necessary. When the remote unit 130 initiates 1506 a reconciliation sequence, it can also set a timer to a predetermined value to provide a maximum time interval for the central terminal 102 to respond to the reconciliation request. While waiting for the response, if the timer times out 1512 then the remote unit 130 determines whether this was, for example, the third try 1514, and if not then it retransmits 1506 the reconciliation request over path A 152 and resets the timer. After a predetermined number of tries, e.g., after three tries 1514, the remote unit 130 may exit the reconciliation sequence and notify 1516 the user of an error condition and wait for an input. While waiting for the response from the central terminal 102, if the remote unit 130 receives 1518 a CRC from the central terminal 102 then it can go and process 1522 the received CRC.

Otherwise, the remote unit 130 continues to wait 1520 for the response from the central terminal 102.

[0084] Once the remote unit 130 receives 1518 the CRC from the central terminal 102, it verifies 1522 that the CRC is in memory 140 and marked "good". That is, if the CRC stored in the memory 140 is marked "good" then the message data 1304 associated with the CRC for the address was completely and correctly received by the remote unit 130. In this case, the remote unit 130 can send 1524 an acknowledgment to the central terminal 102 that the CRC corresponding to the message was marked "good".

[0085] Further, if the message was already deleted 1526 from memory 140, such as when a user has already read and discarded the message, then the remote unit 130 can also delete 1528 the CRC from the memory 140. Otherwise, if the message was not deleted 1526, the CRC remains stored in the memory 140. Subsequently, the remote unit 130 can initiate 1506 another reconciliation request with the central terminal 102 for another address.

[0086] If the CRC of a message is not in memory 140 and marked "good" 1522, then the remote unit 130 can send 1530 an acknowledgment to the central terminal 102 indicating that the CRC of the message is "bad". That is, the "bad" acknowledgment indicates that the message was previously missed by the remote unit 130. In this case, the remote unit 130 monitors 1532 path A 152 for a predetermined time interval for receiving at least the message data 1304 of the message 1300 corresponding to the CRC 1308.

[0087] If at least the message data 1304 is not received 1532 within the predetermined time interval then

the remote unit 130 can send 1534 a NACK message to the central terminal 102. The NACK prompts the central terminal 102 to resend at least the message data 1304 of the message 1300.

[0088] When the remote unit 130 receives 1532 at least the message data 1304 of the message 1300 it then stores 1536 at least the received message data 1304 of the message 1300 in the memory 140. Subsequently, the remote unit 130 can compare 1538 the computed CRC of the received message data 1304 to the received CRC value to determine if there were any errors in the received message data 1304. If the message data was erroneously received 1538, e.g., the computed CRC does not match the received CRC value, then the remote unit 130 sends 1544 a NACK message to the central terminal 102 and then resets the timer to wait the predetermined time interval for receiving 1332 at least a message data 1304. Optionally, the remote unit 130 may repeat this process 1532, 1536, 1538, 1544, for a predetermined number of tries, e.g., three tries, at which time the remote unit 130 may disconnect and terminate communications with the central terminal 102.

[0089] When the computed CRC matches 1538 the received CRC value, indicating that the message data 1304 was completely and correctly received by the remote unit 130, the remote unit 130 then stores 1540 the CRC in the memory 140 and marks it as "good". Further, the remote unit 130 then sends 1542 an acknowledgment to the central terminal 102, acknowledging that the message data 1304 was completely and correctly received by the remote unit 130.

[0090] Then, the remote unit 130 resets 1542 the timer for the time interval to receive a response with a CRC from the central terminal 102, and then goes and monitors 1508, 1512, 1518, for the response from the central terminal 102 and waits 1520. In this way, the remote unit 130 handshakes reconciliation requests and acknowledgments with the central terminal 102 for delivering to the remote unit 130 at least the message data 1304 of messages 1300 that were previously missed by the remote unit 130. Communication over path A 152 can reliably deliver at least the message data 1304 of previously missed messages 1300 from the central terminal 102 to the remote unit 130.

[0091] Therefore, the alternative embodiments of the communication system 100 discussed above can provide the advantages of a high throughput and reliable delivery of messages between the central terminal 102 and the one or more remote units 130.

Claims

1. A method for reliably delivering messages in a communication system from a terminal (102) to a selective call receiver (130), the method comprising the steps of:

a) the terminal (102) storing messages for transmission to a selective call receiver, each message comprising address information (206), a message sequence identifier (208), and message data (204);

b) the terminal (102) sequentially transmitting the messages over a first communication medium (122) for reception by the selective call receiver (130) the message sequence identifiers transmitted with the messages identifying the sequence of transmitted messages that include the same address information;

c) the selective call receiver receiving at least some of the transmitted messages, including the message sequence identifiers associated with the received messages;

d) the selective call receiver generating a message reconciliation request over a second communication medium (152), the second communication medium being different from the first communication medium (122), the message reconciliation request identifying a predetermined address for the selective call receiver and any message sequence identifiers included with the received messages; the method further **CHARACTERIZED BY**

e) monitoring a time associated with a last received message, by means of a controller (136) included in the selective call receiver, to determine when a predetermined amount of time has expired;

f) the controller (136) further determining, after expiration of the predetermined amount of time, that a transmitted message has been missed when the last received message is out of sequence with other messages received by the selective call receiver;

g) the selective call receiver (130) generating, in response to the controller determining that a transmitted message has been missed, the message reconciliation request over the second communication medium (152).

h) the terminal (102) determining whether any messages that were sequentially transmitted in step b) were not received by the selective call receiver by comparing the message sequence identifiers of the stored messages to the message sequence identifiers identified in the message reconciliation request as being received, wherein a stored message is determined to have not been received when the message sequence identifier of a stored message is not identified as received in the message reconciliation request;

i) retrieving each stored message that was determined not to have been received by the selective call receiver in step h); and

j) transmitting over the second communication

medium (152) at least the message data of each of the retrieved messages in step i) for reception by the selective call receiver for reliably delivering messages to the selective call receiver.

2. The method of claim 1 further including, subsequent to step i), the steps of:

j) receiving an acknowledgment from the selective call receiver over the second communication channel in response to step i), the acknowledgment affirmatively acknowledging reception by the selective call receiver of at least the message data of each of the retrieved messages transmitted in step i); and
k) deleting each of the messages stored in step a) that was acknowledged as being received by the selective call receiver in step j).

3. The method of claim 1 further including, subsequent to step i), the step of:

l) repeating steps a) through i), wherein the received message reconciliation request in step f) identifies messages received by the selective call receiver since a previous message reconciliation request was received identifying the predetermined address for the selective call receiver.

4. A communication system (100) for reliably delivering messages from a central terminal (120) to at least one communication receiver (130), wherein the central terminal comprises:

memory means (118) for storing messages destined for transmission to at least one communication receiver;
first message transmitting means (124, 126) coupled to the memory means for sequentially transmitting the messages and message sequence identifiers associated with the messages over a first communication medium (122) for reception by the at least one communication receiver;
second message transmitting means coupled to the memory means for transmitting messages missed by the at least one communication receiver over a second communication medium (152) for reception by the at least one communication receiver (130) in response to reception of a message reconciliation request generated and transmitted by the at least one communication receiver, wherein the message reconciliation request identifies message sequence identifiers associated with messages that have been received by the at least one communication receiver such that missed messages can be identified by the central terminal; and
wherein the at least one communication receiver (130) comprises:

a receiver (134) for receiving at least some of the messages transmitted over the first communication medium; and
reconciliation request means for generating a reconciliation request over the second communication medium, wherein the at least one communication receiver is further **CHARACTERIZED BY**
a controller (136), coupled to the receiver (134) and including means adapted to monitor the message sequence identifiers associated with the received messages, and means adapted to determine that a message transmitted over the first communication medium (122) was not received by detecting that a message sequence identifier associated with a received message is out of sequence with the transmission sequence of other received messages; and
a timer (142), coupled to the controller (136), for providing timing information thereto, wherein the controller is adapted to determine that the transmitted message was not received within a predetermined time interval subsequent to a last received message being monitored in the transmission sequence, and wherein the determination that the transmitted message was not received is delayed by the predetermined time interval for enabling the controller to monitor the transmission sequence up to the expiration of the predetermined time, and

wherein the reconciliation request means is coupled to and responsive to the controller for generating the reconciliation request over the second communication medium (152) in response to the controller determining that the received message is out of sequence with the transmission sequence of the other received messages after expiration of the predetermined time interval.

5. The communication system of claim 4 wherein the second communication medium is a dial-up telephone line interface using modem communication.

6. The communication system of claim 4 wherein the second communication medium is a radio frequency communication channel.

7. A portable selective call receiver (130) operable in cooperation with a communication system (100) for

reliably delivering messages from the communication system to the portable selective call receiver, the portable selective call receiver comprising:

receiving means (134) for receiving messages transmitted over a first communication medium (122) each transmitted message comprising address information (206), a message sequence identifier (208), and message data (204), the message sequence identifiers of transmitted messages identifying a transmission sequence of the transmitted messages that include the same address information;

memory means (140) coupled to the first receiving means for storing the received messages;

decoding means (136) for matching the address information of a received message to a predetermined address;

message reconciliation requesting means for transmitting a message reconciliation request to the communication system over a second communication medium (152) for identifying at least one transmitted message that the portable selective call receiver failed to receive over the first communication medium (122), the message reconciliation request identifying the predetermined address and at least one message sequence identifier, each of the at least one message sequence identifier corresponding to a transmitted message that was not received; and

reconciled message receiving means coupled to the message reconciliation requesting means and responsive thereto for receiving at least the message data of each of the at least one message corresponding to each of the at least one message sequence identifier identified in the message reconciliation request, the reconciled message receiving means receiving at least the message data of each of the at least one message over the second communication medium (152) for reliably delivering messages from the communication system to the portable selective call receiver, and wherein the portable selective call receiver is further **CHARACTERIZED BY**

a controller (136) including

received message sequence monitoring means coupled to the receiving means and the decoding means for monitoring the transmission sequence of received messages that include address information matching the predetermined address,

missed message determining means coupled to the received message sequence monitoring means for determining that a transmitted message including address information matching the predetermined address was not received by the portable selective call receiver by detecting at least one received message having a message sequence identifier that is out of sequence with the transmission sequence of received messages including address information matching the predetermined address, and

message error detecting means coupled to the receiving means (134) and the decoding means (136) for detecting errors in the message data of a received message having address information that matches the predetermined address, and wherein

the message reconciliation requesting means is coupled to the missed message determining means and the message error detecting means for transmitting the message reconciliation request to the communication system over the second communication medium (152) for identifying the at least one transmitted message that the portable selective call receiver (130) failed to receive over the first communication medium (122), the message reconciliation request identifying the predetermined address and at least one message sequence identifier, each of the at least one message sequence identifier corresponding to a transmitted message that was not received, as determined by the missed message determining means, or corresponding to a received message having error in the message data, as detected by the error detection means; and

timing means (142) coupled to the received message sequence monitoring means and the missed message determining means for providing timing information thereto for determining that a transmitted message including address information matching the predetermined address was not received by the portable selective call receiver (130) after a predetermined time interval subsequent to a last received message being monitored in the transmission sequence, the determination that the transmitted message including address information matching predetermined address was not received being delayed by the predetermined time interval for monitoring the transmission sequence up to the expiration of the predetermined time interval.

8. The portable selective call receiver of claim 7, further comprising:

display means coupled to the message reconciliation requesting means for visually indicating to a user that the portable selective call receiver failed to receive at least one transmitted message over the first communication medium; and

user input control means coupled to the message reconciliation requesting means for receiving user input including a user confirmation of the visual indication that the portable selective call receiver failed to receive at least one transmitted message, the received user confirmation being coupled to the message reconciliation requesting means for transmitting the message reconciliation request to the communication system in response to receiving the user confirmation.

9. The portable selective call receiver of claim 7, wherein the first communication medium is a radio frequency paging communication channel, and wherein the second communication medium is one of the set of communication media including a dial-up telephone line interface using modem communication and a radio frequency communication channel.

10. The portable selective call receiver of claim 7, wherein each of the messages transmitted over the first communication medium includes a cyclic redundancy code CRC for detecting at least one error in the message data, and wherein the message error detecting means utilizes the CRC of a received message having address information that matches the predetermined address for detecting error in the message data of the received message.

Patentansprüche

1. Verfahren zur zuverlässigen Übermittlung von Nachrichten in einem Kommunikationssystem von einer Endeinrichtung (102) zu einem selektiven Rufempfänger (130), wobei das Verfahren die folgenden Schritte umfasst:

a) die Endeinrichtung (102) speichert Nachrichten zur Übertragung an einen selektiven Rufempfänger, wobei jede Nachricht Adressinformationen (206), eine Nachrichtensequenzkennung (208) und Nachrichtendaten (204) umfasst;
b) die Endeinrichtung (102) überträgt die Nachrichten sequentiell über ein erstes Kommunikationsmedium (122) zum Empfang durch den selektiven Rufempfänger (130), wobei die mit den Nachrichten übertragenen Nachrichtensequenzkennungen die Sequenz von übertragenen Nachrichten kennzeichnen, die dieselben Adressinformationen enthalten;
c) der selektive Rufempfänger empfängt wenigstens einige der übertragenen Nachrichten einschließlich der zu den empfangenen Nachrichten gehörigen Nachrichtensequenzkennungen;
d) der selektive Rufempfänger erzeugt eine Aufforderung zum Nachrichtenabgleich über ein zweites Kommunikationsmedium (152), wobei das zweite Kommunikationsmedium von dem ersten Kommunikationsmedium (122) verschieden ist, und wobei die Aufforderung zum Nachrichtenabgleich eine vorbestimmte Adresse für den selektiven Rufempfänger und sämtliche in den empfangenen Nachrichten enthaltenen Nachrichtensequenzkennungen identifiziert; wobei das Verfahren ferner **dadurch gekennzeichnet ist, dass**
e) eine zu einer zuletzt empfangenen Nachricht gehörige Zeit mit Hilfe eines in dem selektiven Rufempfänger enthaltenen Steuergeräts (136) überwacht wird, um festzustellen, wann eine vorbestimmte Zeitdauer abgelaufen ist;
f) das Steuergerät (136) nach Ablauf der vorbestimmten Zeitdauer weiterhin feststellt, dass eine übertragene Nachricht verpasst wurde, wenn die zuletzt empfangene Nachricht nicht in der Sequenz der anderen durch den selektiven Rufempfänger empfangenen Nachrichten liegt;
g) der selektive Rufempfänger (130) in Reaktion auf die Feststellung des Steuergeräts, dass eine übertragene Nachricht verpasst wurde, die Aufforderung zum Nachrichtenabgleich über das zweite Kommunikationsmedium (152) erzeugt;
h) die Endeinrichtung (102) feststellt, ob irgendwelche Nachrichten, die in Schritt b) sequentiell übertragen wurden, nicht durch den selektiven Rufempfänger empfangen wurden, indem sie die Nachrichtensequenzkennungen der gespeicherten Nachrichten mit den bei der Aufforderung zum Nachrichtenabgleich als empfangen identifizierten Nachrichtensequenzkennungen vergleicht, wobei eine gespeicherte Nachricht als nicht empfangen gilt, wenn die Nachrichtensequenzkennung einer gespeicherten Nachricht bei der Aufforderung zum Nachrichtenabgleich nicht als empfangen identifiziert wird;
i) jede gespeicherte Nachricht, die in Schritt h) als nicht durch den selektiven Rufempfänger empfangen ermittelt wurde, abgerufen wird; und
j) über das zweite Kommunikationsmedium (152) wenigstens die Nachrichtendaten jeder der in Schritt i) abgerufenen Nachrichten zum Empfang durch den selektiven Rufempfänger übertragen werden, um Nachrichten zuverlässig zu dem selektiven Rufempfänger zu übermitteln.

2. Verfahren nach Anspruch 1, das ferner im An-

schluss an Schritt i) die folgenden Schritte umfasst:

j) von dem selektiven Rufempfänger wird über den zweiten Übertragungskanal in Reaktion auf Schritt i) eine Bestätigung empfangen, wobei die Bestätigung den Empfang wenigstens der Nachrichtendaten jeder der in Schritt i) übertragenen abgerufenen Nachrichten durch den selektiven Rufempfänger bejaht; und

k) jede der in Schritt a) gespeicherten Nachrichten, die in Schritt j) als durch den selektiven Rufempfänger empfangen bestätigt wurde, wird gelöscht.

3. Verfahren nach Anspruch 1, das ferner im Anschluss an Schritt i) den folgenden Schritt umfasst:

l) die Schritte a) bis i) werden wiederholt, wobei die in Schritt f) erfolgte Aufforderung zum Abgleich empfangener Nachrichten durch den selektiven Rufempfänger empfangene Nachrichten identifiziert, die seit einer früheren Aufforderung zum Nachrichtenabgleich empfangen wurden, die die vorbestimmte Adresse für den selektiven Rufempfänger identifiziert.

4. Kommunikationssystem (100) zur zuverlässigen Übermittlung von Nachrichten von einer zentralen Endeinrichtung (102) zu mindestens einem Kommunikationsempfänger (130), wobei die zentrale Endeinrichtung folgendes umfasst:

eine Speichereinrichtung (118) zum Speichern von Nachrichten, die zur Übertragung zu mindestens einem Kommunikationsempfänger bestimmt sind;

eine mit der Speichereinrichtung gekoppelte erste Nachrichtenübertragungseinrichtung (124, 126) zur sequentiellen Übertragung der Nachrichten und zu den Nachrichten gehörigen Nachrichtensequenzkennungen über ein erstes Kommunikationsmedium (122) zum Empfang durch den mindestens einen Kommunikationsempfänger;

eine mit der Speichereinrichtung gekoppelte zweite Nachrichtenübertragungseinrichtung zur Übertragung von Nachrichten, die durch den mindestens einen Kommunikationsempfänger verpasst wurden, über ein zweites Kommunikationsmedium (152) zum Empfang durch den mindestens einen Kommunikationsempfänger (130) in Reaktion auf den Empfang einer durch den mindestens einen Kommunikationsempfänger erzeugten und übertragenen Aufforderung zum Nachrichtenabgleich, wobei die Aufforderung zum Nachrichtenabgleich Nachrichtensequenzkennungen identifiziert, die zu den Nachrichten gehören, die durch den mindestens einen Kommunikationsempfänger empfangen wurden, so daß verpasste Nachrichten durch die zentrale Endeinrichtung identifiziert werden können; und

wobei der mindestens eine Kommunikationsempfänger (130) folgendes umfasst:

einen Empfänger (134) zum Empfang mindestens einiger der über das erste Kommunikationsmedium übertragenen Nachrichten; und

eine den Abgleich verlangende Einrichtung zum Erzeugen einer Aufforderung zum Abgleich über das zweite Kommunikationsmedium, wobei der mindestens eine Kommunikationsempfänger ferner **gekennzeichnet ist durch**:

ein Steuergerät (136), das mit dem Empfänger (134) gekoppelt ist und eine Einrichtung umfasst, die die zu den empfangenen Nachrichten gehörigen Nachrichtensequenzkennungen überwachen kann, und eine Einrichtung, die feststellen kann, dass eine über das erste Kommunikationsmedium (122) übertragene Nachricht nicht empfangen wurde, indem sie feststellt, dass eine zu einer empfangenen Nachricht gehörige Nachrichtensequenzkennung nicht in der Übertragungssequenz anderer empfangener Nachrichten liegt; und

einen Zeitgeber (142), der mit dem Steuergerät (136) gekoppelt ist, um diesem Zeitinformationen zu liefern, wobei das Steuergerät feststellen kann, dass die übertragene Nachricht nicht innerhalb eines vorbestimmten Zeitraums im Anschluss an eine in der Übertragungssequenz überwachte, zuletzt empfangene Nachricht empfangen wurde, und wobei die Feststellung, dass die übertragene Nachricht nicht empfangen wurde, um den vorbestimmten Zeitraum verzögert wird, damit das Steuergerät die Übertragungssequenz bis zum Ablauf der vorbestimmten Zeit überwachen kann; und

wobei die den Abgleich verlangende Einrichtung mit dem Steuergerät gekoppelt ist und darauf anspricht, um die Aufforderung zum Abgleich über das zweite Kommunikationsmedium (152) zu erzeugen, wenn das Steuergerät feststellt, dass die empfangene Nachricht nach Ablauf des vorbestimmten Zeitraums nicht in der Übertragungsse-

quenz der anderen empfangenen Nachrichten liegt.

5. Kommunikationssystem nach Anspruch 4, bei dem das zweite Kommunikationsmedium eine mit Modemkommunikation arbeitende Wähltelefonleitungsschnittstelle ist.

6. Kommunikationssystem nach Anspruch 4, bei dem das zweite Kommunikationsmedium ein Hochfrequenzübertragungskanal ist.

7. Tragbarer selektiver Rufempfänger (130), der in Zusammenarbeit mit einem Kommunikationssystem (100) betrieben werden kann, für die zuverlässige Übermittlung von Nachrichten von dem Kommunikationssystem zu dem tragbaren selektiven Rufempfänger, wobei der tragbare selektive Rufempfänger folgendes umfasst:

eine Empfangseinrichtung (134) zum Empfang von Nachrichten, die über ein erstes Kommunikationsmedium (122) übertragen wurden, wobei jede übertragene Nachricht Adressinformationen (206), eine Nachrichtensequenzkennung (208) und Nachrichtendaten (204) umfasst, wobei die Nachrichtensequenzkennungen übertragener Nachrichten eine Übertragungssequenz der übertragenen Nachrichten kennzeichnen, die dieselben Adressinformationen enthalten;
eine mit der ersten Empfangseinrichtung gekoppelte Speichereinrichtung (140) zum Speichern der empfangenen Nachrichten;
eine Decodiereinrichtung (136), um die Adressinformationen einer empfangenen Nachricht mit einer vorbestimmten Adresse in Übereinstimmung zu bringen;
eine den Nachrichtenabgleich verlangende Einrichtung zum Übertragen einer Aufforderung zum Nachrichtenabgleich zu dem Kommunikationssystem über ein zweites Kommunikationsmedium (152) zur Identifizierung wenigstens einer übertragenen Nachricht, die der tragbare selektive Rufempfänger nicht über das erste Kommunikationsmedium (122) empfangen konnte, wobei die Aufforderung zum Nachrichtenabgleich die vorbestimmte Adresse und wenigstens eine Nachrichtensequenzkennung identifiziert und die wenigstens eine Nachrichtensequenzkennung jeweils einer übertragenen Nachricht entspricht, die nicht empfangen wurde; und
eine Einrichtung zum Empfang abgeglichener Nachrichten, die mit der den Nachrichtenabgleich verlangenden Einrichtung gekoppelt ist und darauf anspricht, um jeweils wenigstens die Nachrichtendaten der wenigstens einen Nachricht zu empfangen, die jeweils der wenigstens einen, bei der Aufforderung zum Nachrichtenabgleich identifizierten Nachrichtensequenzkennung entspricht, wobei die Einrichtung zum Empfang abgeglichener Nachrichten jeweils wenigstens die Nachrichtendaten der wenigstens einen Nachricht über das zweite Kommunikationsmedium (152) empfängt, um Nachrichten zuverlässig von dem Kommunikationssystem zu dem tragbaren selektiven Rufempfänger zu übermitteln, und wobei der tragbare selektive Rufempfänger ferner **gekennzeichnet ist durch**:

ein Steuergerät (136), das folgendes umfasst:

eine Einrichtung zur Überwachung der Sequenz empfangener Nachrichten, die mit der Empfangseinrichtung und der Decodiereinrichtung gekoppelt ist, um die Übertragungssequenz empfangener Nachrichten zu überwachen, die Adressinformationen enthalten, die zu der vorbestimmten Adresse passen,

eine Einrichtung zur Ermittlung verpasster Nachrichten, die mit der Einrichtung zur Überwachung der Sequenz empfangener Nachrichten gekoppelt ist, um festzustellen, dass eine übertragene Nachricht mit Adressinformationen, die zu der vorbestimmten Adresse passen, nicht **durch** den tragbaren selektiven Rufempfänger empfangen wurde, indem sie mindestens eine empfangene Nachricht mit einer Nachrichtensequenzkennung erfasst, die nicht in der Übertragungssequenz empfangener Nachrichten mit Adressinformationen, die zu der vorbestimmten Adresse passen, liegt, und
eine Einrichtung zur Erfassung von Nachrichtenfehlern, die mit der Empfangseinrichtung (134) und der Decodiereinrichtung (136) gekoppelt ist, um Fehler in den Nachrichtendaten einer empfangenen Nachricht mit Adressinformationen, die zu der vorbestimmten Adresse passen, zu erfassen, und wobei
die den Nachrichtenabgleich verlangende Einrichtung mit der Einrichtung zur Ermittlung verpasster Nachrichten und der Einrichtung zur Erfassung von Nachrichtenfehlern gekoppelt ist, um die Aufforderung zum Nachrichtenabgleich über das zweite Kommunikationsmedium (152) zu dem Kommunikationssystem zu übertragen, um die wenigstens eine übertragene Nach-

richt zu identifizieren, die der tragbare selektive Rufempfänger (130) nicht über das erste Kommunikationsmedium (122) empfangen konnte, wobei die Aufforderung zum Nachrichtenabgleich die vorbestimmte Adresse und wenigstens eine Nachrichtensequenzkennung identifiziert, und wobei die wenigstens eine Nachrichtensequenzkennung jeweils einer übertragenen Nachricht entspricht, die nicht empfangen wurde, wie **durch** die Einrichtung zur Ermittlung verpasster Nachrichten festgestellt wurde, oder einer empfangenen Nachricht mit Fehlern in den Nachrichtendaten entspricht, wie **durch** die Fehlererfassungseinrichtung festgestellt wurde; und

eine Zeitgebereinrichtung (142) die mit der Einrichtung zur Überwachung der Sequenz empfangener Nachrichten und der Einrichtung zur Ermittlung verpasster Nachrichten gekoppelt ist, um diesen Zeitinformationen zu liefern, um festzustellen, dass eine übertragene Nachricht mit Adressinformationen, die zu der vorbestimmten Adresse passen, nach einem vorbestimmten Zeitraum im Anschluss an eine zuletzt empfangene Nachricht, die in der Übertragungssequenz überwacht wurde, nicht **durch** den tragbaren selektiven Rufempfänger (130) empfangen wurde, wobei die Feststellung, dass die übertragene Nachricht mit Adressinformationen, die zu der vorbestimmten Adresse passen, nicht empfangen wurde, um den vorbestimmten Zeitraum zur Überwachung der Übertragungssequenz bis zum Ablauf des vorbestimmten Zeitraums verzögert wird.

8. Tragbarer selektiver Rufempfänger nach Anspruch 7, der ferner folgendes umfasst:

eine Anzeigeeinrichtung, die mit der den Nachrichtenabgleich verlangenden Einrichtung gekoppelt ist, um einem Benutzer optisch anzuzeigen, dass der tragbare selektive Rufempfänger wenigstens eine übertragene Nachricht nicht über das erste Kommunikationsmedium empfangen konnte; und

eine Einrichtung für Benutzer-Steuereingaben, die mit der den Nachrichtenabgleich verlangenden Einrichtung gekoppelt ist, um eine Benutzereingabe einschließlich einer Benutzerbestätigung der optischen Anzeige, dass der tragbare selektive Rufempfänger wenigstens eine übertragene Nachricht nicht empfangen konnte, zu empfangen, wobei die empfangene Benutzerbestätigung mit der den Nachrichtenabgleich verlangenden Einrichtung gekoppelt ist, um die Aufforderung zum Nachrichtenabgleich in Reaktion auf den Empfang der Benutzerbestätigung zu dem Kommunikationssystem zu übertragen.

9. Tragbarer selektiver Rufempfänger nach Anspruch 7, bei dem das erste Kommunikationsmedium ein Hochfrequenz-Rufübertragungskanal ist, und bei dem das zweite Kommunikationsmedium eines aus dem Satz von Kommunikationsmedien ist, der eine mit Modemkommunikation arbeitende Wähltelefonleitungsschnittstelle und einen Hochfrequenzübertragungskanal umfasst.

10. Tragbarer selektiver Rufempfänger nach Anspruch 7, bei dem jede der über das erste Kommunikationsmedium übertragenen Nachrichten einen zyklischen Redundanzcode (CRC) zur Erfassung wenigstens eines Fehlers in den Nachrichtendaten umfasst, und bei dem die Einrichtung zur Erfassung von Nachrichtenfehlern den CRC einer empfangenen Nachricht mit Adressinformationen, die zu der vorbestimmten Adresse passen, benutzt, um Fehler in den Nachrichtendaten der empfangenen Nachricht zu erfassen.

Revendications

1. Procédé permettant de délivrer de manière fiable des messages dans un système de transmission, d'un terminal (102) à un récepteur d'appels sélectifs (130), le procédé comprenant les opérations consistant en ce que :

a) le terminal (102) stocke des messages en vue de leur transmission à un récepteur d'appels sélectifs, chaque message comprenant des informations d'adresse (206), un identificateur de séquence de messages (208), et des données de message (204) ;

b) le terminal (102) émet séquentiellement les messages sur un premier support de transmission (122) en vue de leur réception par le récepteur d'appels sélectifs (130), les identificateurs de séquence de messages transmis avec les messages identifiant la séquence de messages transmis qui contiennent les informations relatives à la même adresse ;

c) le récepteur d'appels sélectifs reçoit au moins certains des messages émis, comportant les identificateurs de séquence de messages associés avec les messages reçus ; et

d) le récepteur d'appels sélectifs produit une demande de conciliation de messages sur un deuxième support de transmission (152), le deuxième support de transmission étant diffé-

rent du premier support de transmission (122), la demande de conciliation de messages identifiant une adresse prédéterminée relative au récepteur d'appels sélectifs et tous les identificateurs de séquence de messages inclus avec les messages reçus ;
le procédé étant **caractérisé en ce que** :

e) on contrôle le temps associé au dernier message reçu, au moyen d'un dispositif de commande (136) inclus dans le récepteur d'appels sélectifs, afin de déterminer lorsqu'une durée prédéterminée a expirée ;
f) le dispositif de commande (136) détermine en outre, après expiration de la durée prédéterminée, qu'un message émis est manquant lorsque le dernier message reçu est hors de la succession avec d'autres messages reçus par le récepteur d'appels sélectifs ;
g) le récepteur d'appels sélectifs (130) produit, en réponse au fait que le dispositif de commande a déterminé qu'un message émis était manquant, la demande de conciliation de messages via le deuxième support de transmission (152);
h) le terminal (102) détermine si des messages, qui ont été séquentiellement émis lors de l'opération b) n'ont pas été reçus par le récepteur d'appels sélectifs en comparant les identificateurs de séquence de messages des messages stockés aux identificateurs de séquence de messages identifiés dans la demande de conciliation de messages telle qu'elle a été reçue, où un message stocké est déterminé comme n'ayant pas été reçu lorsque l'identificateur de séquence de messages d'un message stocké n'est pas identifié comme reçu dans la demande de conciliation de messages ;
i) on récupère chaque message stocké qui a été déterminé comme n'ayant pas été reçu par le récepteur d'appels sélectifs lors de l'opération h) ; et
j) on émet sur le deuxième support de transmission (152) au moins les données de message de chacun des messages récupérés lors de l'opération i) en vue de leur réception par le récepteur d'appels sélectifs afin de délivrer de manière fiable des messages au récepteur d'appels sélectifs.

2. Procédé selon la revendication 1, comportant en outre, à la suite de l'opération i), une opération suivante :

j) recevoir un accusé de réception de la part du récepteur d'appels sélectifs via le deuxième canal de transmission en réponse à l'opération i), l'accusé de réception accusant affirmativement réception par le récepteur d'appels sélectifs, d'au moins les données de message de chacun des messages récupérés émis lors de l'opération i); et
k) supprimer chacun des messages stockés lors de l'opération a), dont on avait accusé réception comme étant reçu par le récepteur d'appels sélectifs lors de l'opération j).

3. Procédé selon la revendication 1, comportant en outre, à la suite de l'opération i) l'opération suivante :

l) répéter les opérations a) à i), où la demande de conciliation de messages reçus de l'opération f) identifie les messages reçus par le récepteur d'appels sélectifs depuis qu'une demande de conciliation de messages précédente a été reçue identifiant l'adresse prédéterminée pour le récepteur d'appels sélectifs.

4. Système de transmission (100) permettant de délivrer de manière fiable des messages d'un terminal central (102) à au moins un récepteur de transmission (130), où le terminal central comprend :

un moyen de mémorisation (118) servant à stocker des messages destinés à être transmis à au moins un récepteur de transmission ;
un premier moyen d'émission de messages (124, 126) couplé au moyen de mémorisation afin d'émettre séquentiellement les messages et des identificateurs de séquence de messages associés avec les messages via un premier support de transmission (122) en vue de leur réception par le ou les récepteurs de transmission ;
un deuxième moyen d'émission de messages couplé au moyen de mémorisation afin d'émettre des messages perdus par le ou les récepteurs de transmission via un deuxième support de transmission (152) en vue de leur réception par le ou les récepteurs de transmission (130) en réponse à la réception d'une demande de conciliation de messages produite et émise par le ou les récepteurs de transmission, où la demande de conciliation de messages identifie des identificateurs de séquence de messages associés avec des messages qui ont été reçus par le ou les récepteurs de transmission de façon que des messages perdus puissent être identifiés par le terminal central ; et
où le ou les récepteurs de transmission (130) comprennent :

un récepteur (134) destiné à recevoir au

moins certains des messages émis via le premier support de transmission ; et
un moyen de demande de conciliation servant à produire une demande de conciliation sur le deuxième support de transmission, où le ou les récepteurs de transmission sont en outre **caractérisés par** :

un dispositif de commande (136) couplé au récepteur (134) et comportant un moyen destiné à contrôler les identificateurs de séquence de messages associés aux messages reçus, et un moyen conçu pour déterminer qu'un message émis via le premier support de transmission (122) n'a pas été reçu par détection du fait qu'un identificateur de séquence de messages associé à un messages reçu est hors de séquence par rapport à la séquence d'émissions d'autres messages reçus ; et
une minuterie (142) couplée au dispositif de commande (136) et servant à fournir des informations temporelles à ce dernier, où le dispositif de commande est conçu pour déterminer que le message émis n'a pas été reçu dans la limite d'un intervalle de temps prédéterminé faisant suite au dernier message reçu qui est contrôlé dans la séquence d'émission, et où la détermination du fait que le message émis n'a pas été reçu est retardée de l'intervalle de temps prédéterminé afin de permettre au dispositif de commande de contrôler la séquence d'émissions jusqu'à l'expiration du temps prédéterminé ; et
où le moyen de demande de conciliation est couplé au dispositif de commande et répond à celui-ci en produisant la demande de conciliation via le deuxième support de transmission (152) en réponse au fait que le dispositif de commande détermine que le message reçu est hors de séquence par rapport à la séquence d'émissions des autres messages reçus, après expiration de l'intervalle de temps prédéterminé.

5. Système de transmission selon la revendication 4, où le deuxième support de transmission est une interface de ligne téléphonique à établir qui utilise une transmission par modem.

6. Système de transmission selon la revendication 4, où le deuxième support de transmission est un canal de transmission de fréquence radio.

7. Récepteur portatif d'appels sélectifs (130) ayant pour fonction, en coopération avec un système de transmission (100), de délivrer de manière fiable des messages, du système de transmission au récepteur portatif d'appels sélectifs, le récepteur portatif d'appels sélectifs comprenant :

un moyen de réception (134) servant à recevoir des messages émis sur un premier support de transmission (122), chaque message émis comprenant des informations d'adresse (206), un identificateur de séquence de messages (208), et des données de message (204), les identificateurs de séquence de messages des messages émis identifiant une séquence d'émissions de messages émis qui comprennent les mêmes informations d'adresse ;
un moyen de mémorisation (140) couplé audit premier moyen de réception afin de stocker les messages reçus ;
un moyen de décodage (136) servant à mettre en correspondance les informations d'adresse d'un message reçu avec une adresse prédéterminée ;
un moyen de demande de conciliation de messages servant à transmettre une demande de conciliation de messages au système de transmission via un deuxième support de transmission (152) afin d'identifier au moins un message émis que le récepteur portatif d'appels sélectifs n'a pas réussi à recevoir via le deuxième moyen de transmission (122), la demande de conciliation de messages identifiant l'adresse prédéterminée et au moins un identificateur de séquence de messages, l'identificateur ou chaque identificateur de séquence de messages correspondant à un message émis qui n'a pas été reçu ; et
un moyen de réception de message concilié couplé au moyen de demande de conciliation de messages et répondant à celui-ci de façon à recevoir au moins les données de message du message ou de chaque message correspondant à l'identificateur ou à chaque identificateur de séquence de messages identifié dans la demande de conciliation de messages, le moyen de réception de message concilié recevant au moins les données de message du message ou de chaque message via le deuxième support de transmission (52) afin de délivrer de manière fiable des messages, du système de transmission au récepteur portatif d'appels sélectifs, et où le récepteur portatif d'appels sélectifs est en outre **caractérisé par** :

un dispositif de commande (136) comportant :

un moyen de contrôle de séquence de messages reçus couplé au moyen de réception et au moyen de décodage afin de contrôler la séquence d'émissions de messages reçus qui contiennent des informations d'adresse correspondant à l'adresse prédéterminée,
un moyen de détermination de message manquant couplé au moyen de contrôle de séquence de messages reçus servant à déterminer qu'un message émis comportant des informations d'adresse qui correspondent à l'adresse prédéterminée n'a pas été reçue par le récepteur portatif d'appels sélectifs par détection d'au moins un message reçu ayant un identificateur de séquence de messages qui est hors de séquence par rapport à la séquence d'émissions de messages reçus comportant les informations d'adresse qui correspondent à l'adresse prédéterminée ; et
un moyen de détection d'erreur de message couplé au moyen de réception (134) et au moyen de décodage (136) afin de détecter des erreurs dans les données de message d'un message reçu ayant des informations d'adresse qui correspondent à l'adresse prédéterminée, et où :

le moyen de demande de conciliation de messages est couplé au moyen de détermination de message manquant et au moyen de détection d'erreur de message afin de transmettre la demande de conciliation de messages au système de transmission via le deuxième moyen de transmission (152) afin d'identifier le ou les messages que le récepteur portatif d'appels sélectifs (130) n'a pas réussi à recevoir via le premier support de transmission (122), la demande de conciliation de messages identifiant l'adresse prédéterminée et au moins un identificateur de séquence de messages, l'identificateur ou chaque identificateur de séquence de messages correspondant à un message émis qui n'a pas été reçu, comme déterminé par le moyen de détermination de message manquant, ou correspondant à un message reçu comportant une erreur dans les données de message, comme détecté par le moyen de détection d'erreur ; et
un moyen de minuterie (142) couplé au moyen de contrôle de séquence de messages reçus et au moyen de détermination de message manquant afin de fournir des informations temporelles à celui-ci pour déterminer qu'un message émis comportant des informations d'adresse qui correspondent à l'adresse prédéterminée n'a pas été reçu par le récepteur portatif d'appels sélectifs (130) après un intervalle de temps prédéterminé faisant suite au dernier message reçu contrôlé dans la séquence d'émissions, la détermination du fait que le message émis comportant les informations d'adresse qui correspondent à l'adresse prédéterminée n'a pas été reçu étant retardée de l'intervalle de temps prédéterminé pendant le contrôle de la séquence d'émissions, jusqu'à expiration de l'intervalle de temps prédéterminé.

8. Récepteur portatif d'appels sélectifs selon la revendication 7, comprenant en outre :

un moyen d'affichage couplé au moyen de demande de conciliation de messages de façon à indiquer visuellement à un utilisateur que le récepteur portatif d'appels sélectifs n'a pas réussi à recevoir au moins un message émis via le premier support de transmission ; et
un moyen de commande d'entrée d'utilisateur couplé au moyen de demande de conciliation de messages afin de recevoir une entrée de la part de l'utilisateur, qui comporte une confirmation, par l'utilisateur, de l'indication visuelle du fait que le récepteur portatif d'appels sélectifs n'a pas réussi à recevoir au moins un message émis, la confirmation de l'utilisateur, une fois reçue, étant couplée au moyen de demande de conciliation de messages afin de transmettre la demande de conciliation de messages au système de transmission en réponse à la réception de la confirmation de l'utilisateur.

9. Récepteur portatif d'appels sélectifs selon la revendication 7, où le premier support de transmission

est un canal de transmission d'appels de personnes de fréquence radio, et où le deuxième support de transmission est un élément du groupe de supports de transmission qui comprend une interface de ligne téléphonique à composer qui utilise une transmission par modem et un canal de transmission de fréquence radio.

10. Récepteur portatif d'appels sélectifs selon la revendication 7, où chacun des messages émis sur le premier support de transmission comporte un code de redondance cyclique noté CRC permettant de détecter au moins une erreur dans les données de message, et où le moyen de détection d'erreur de message utilise le CRC d'un message reçu possédant des informations d'adresse qui correspondent à l'adresse prédéterminée pour détecter l'erreur présente dans les données de message du message reçu.

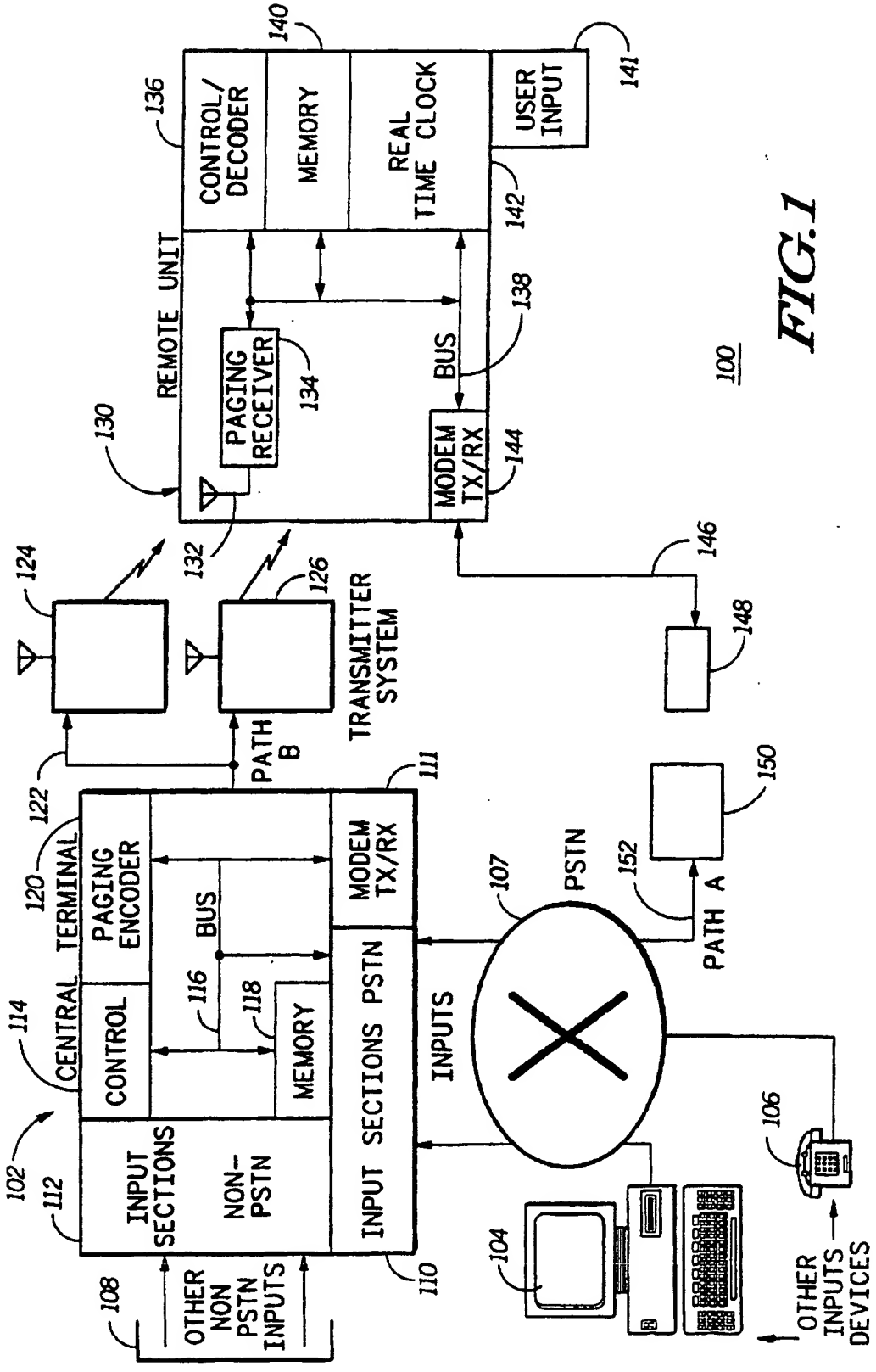

REMOTE UNIT
CONTROL/ DECODER
MEMORY
REAL TIME CLOCK
USER INPUT
PAGING RECEIVER
BUS
MODEM TX/RX
TRANSMITTER SYSTEM
PATH B
PATH A
PSTN
CENTRAL TERMINAL
PAGING ENCODER
CONTROL
MEMORY
BUS
MODEM TX/RX
INPUT SECTIONS
NON-PSTN
INPUT SECTIONS PSTN
INPUTS
OTHER NON PSTN INPUTS
OTHER INPUTS DEVICES
100
102
104
106
107
108
110
111
112
114
116
118
120
122
124
126
130
132
134
136
138
140
141
142
144
146
148
150
152

FIG. 1

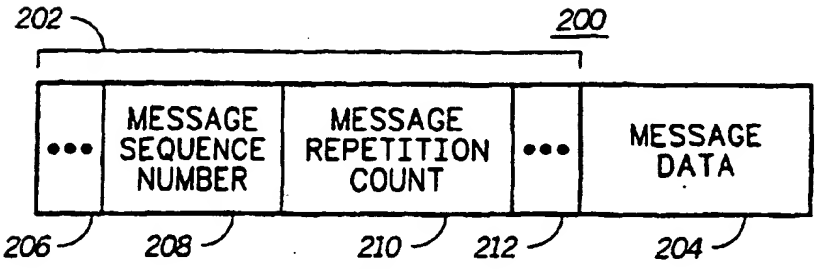
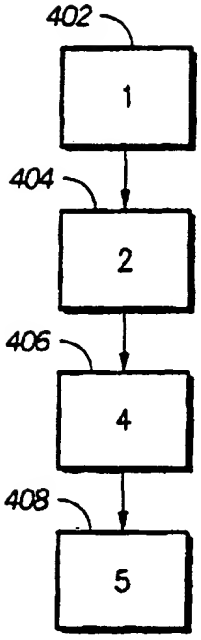


FIG.2



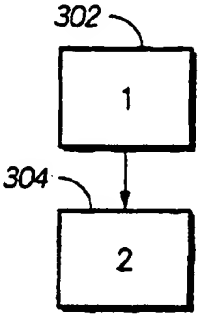
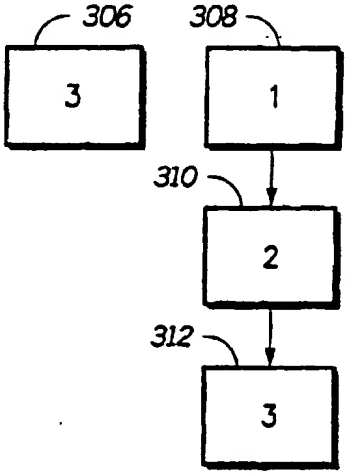


FIG.3



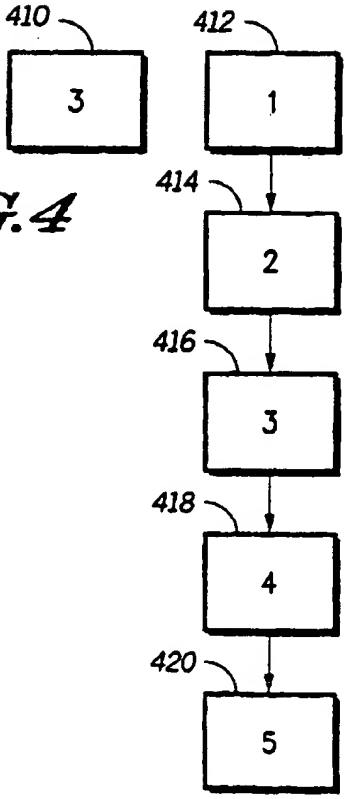


FIG.4

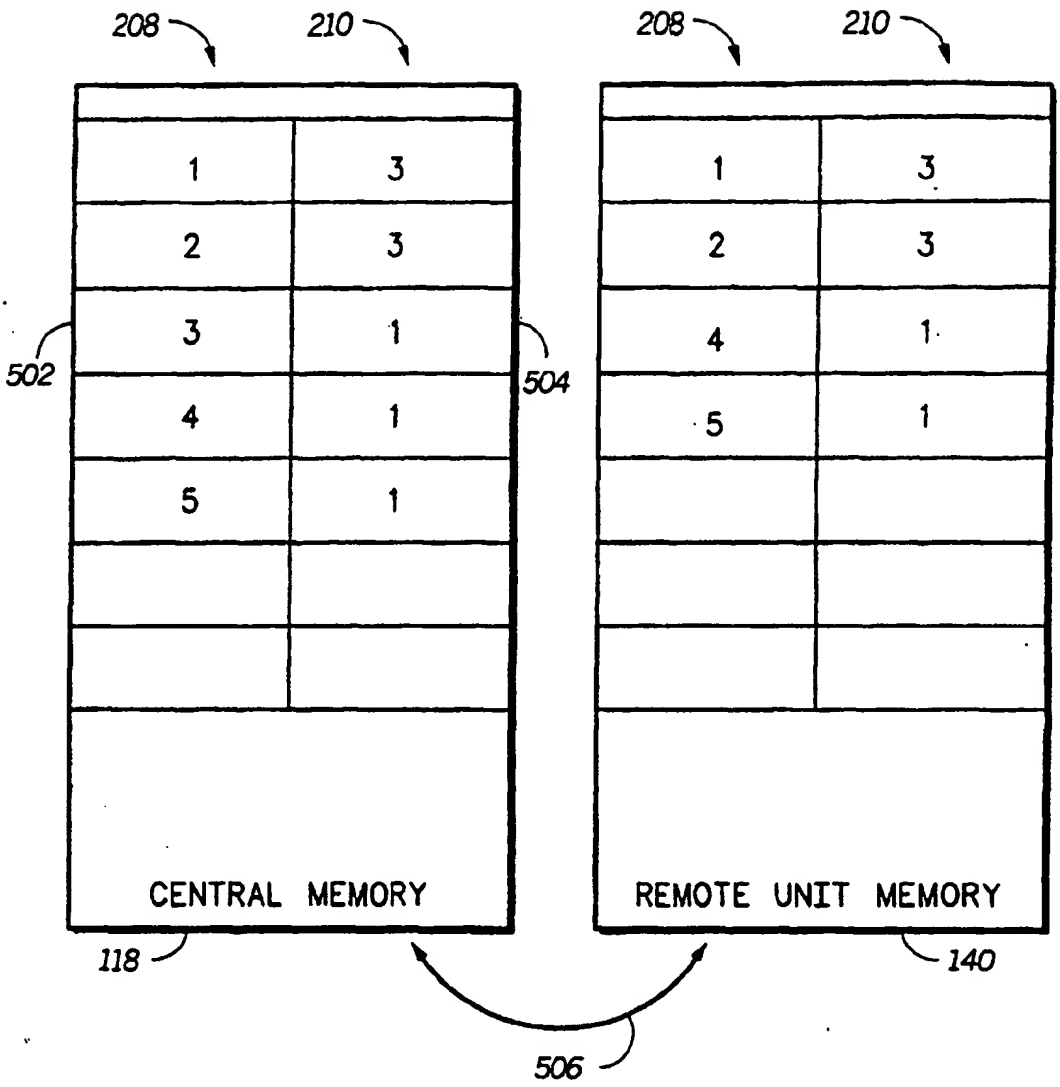

208
210
208
210
1
3
2
3
3
1
4
1
5
1
1
3
2
3
4
1
5
1
502
504
CENTRAL MEMORY
REMOTE UNIT MEMORY
118
140
506
RECONCILE TX MSGS AGAINST RX MSGS

FIG.5

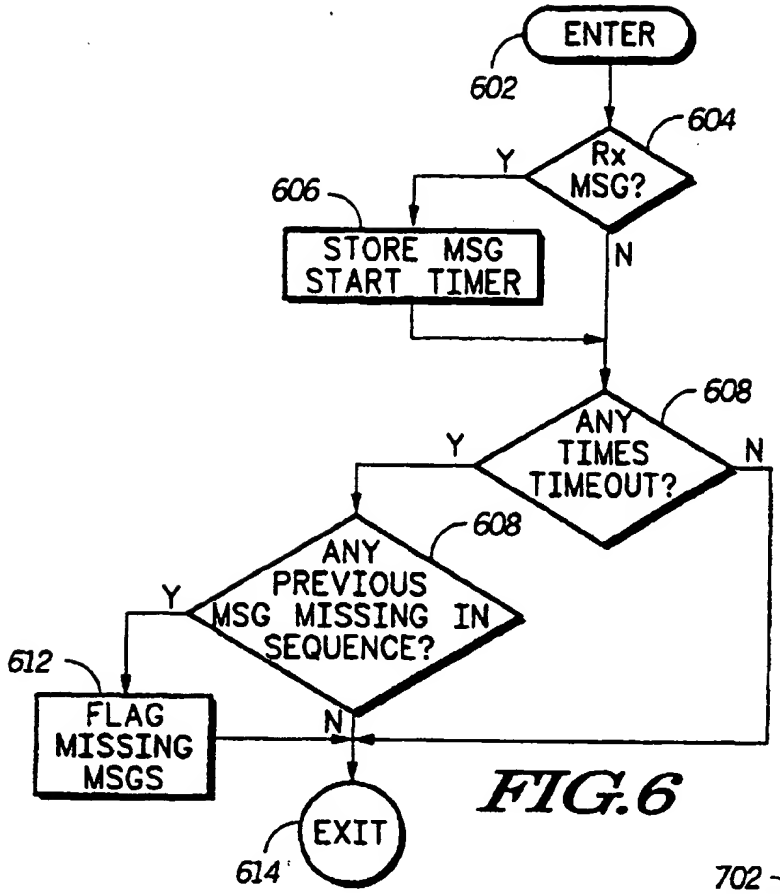


FIG.6

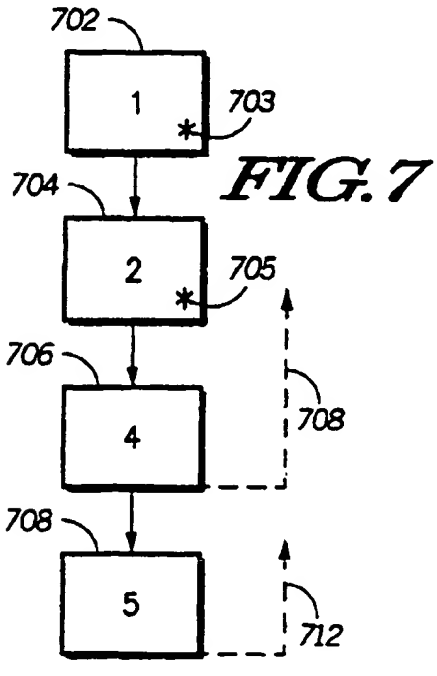


FIG.7

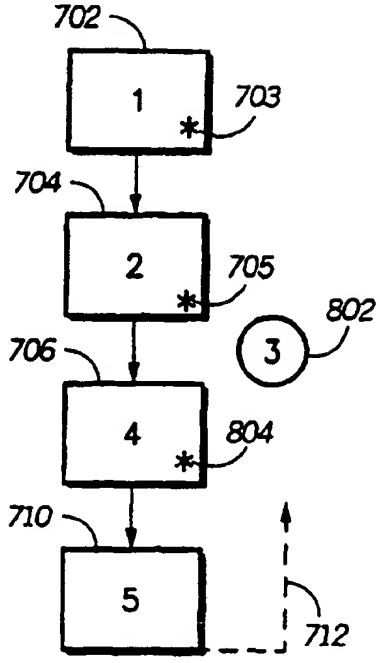


FIG.8

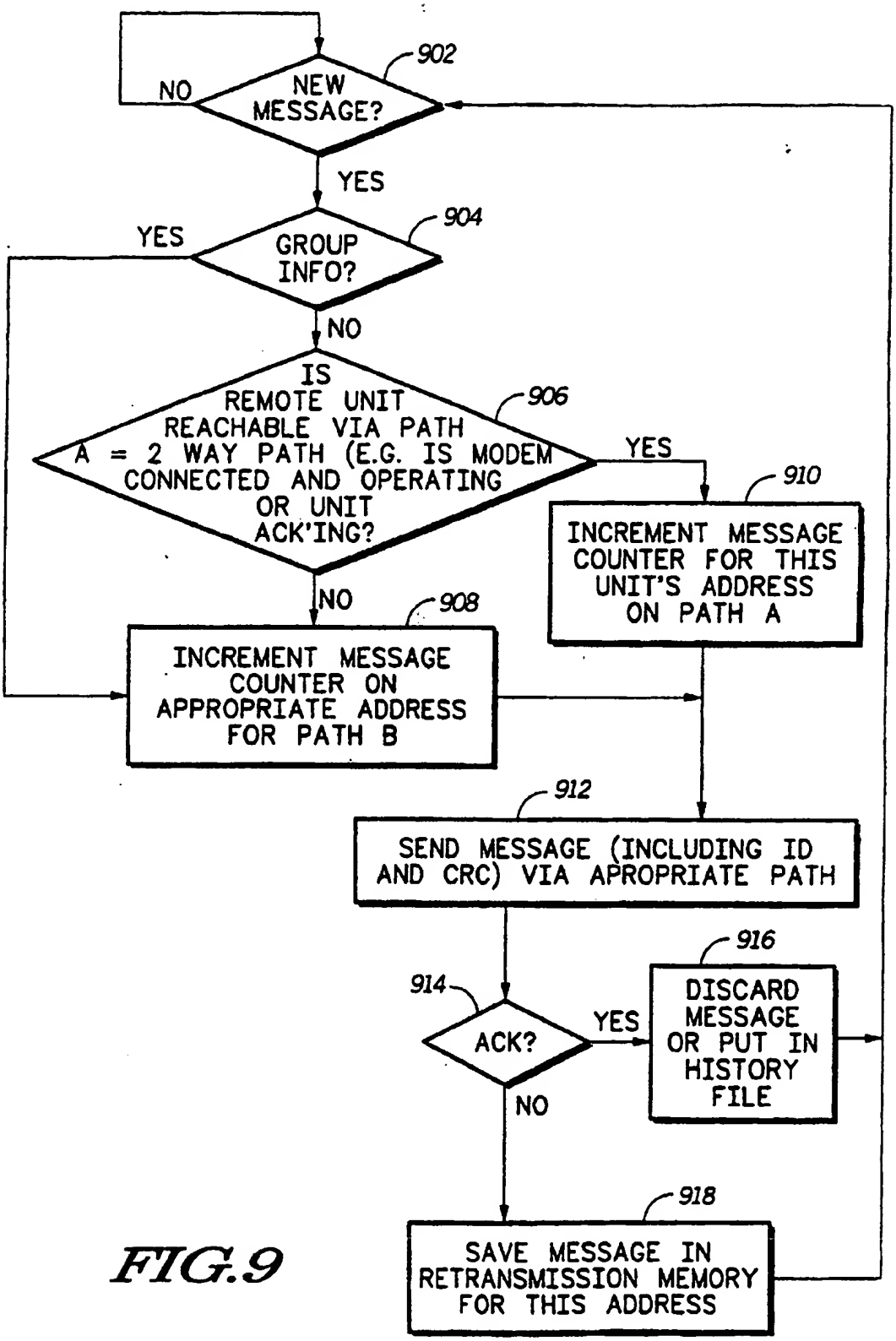

902
NEW MESSAGE?
NO
YES
904
GROUP INFO?
YES
NO
906
IS REMOTE UNIT REACHABLE VIA PATH A = 2 WAY PATH (E.G. IS MODEM CONNECTED AND OPERATING OR UNIT ACK'ING?
YES
910
INCREMENT MESSAGE COUNTER FOR THIS UNIT'S ADDRESS ON PATH A
NO
908
INCREMENT MESSAGE COUNTER ON APPROPRIATE ADDRESS FOR PATH B
912
SEND MESSAGE (INCLUDING ID AND CRC) VIA APROPRIATE PATH
914
ACK?
YES
916
DISCARD MESSAGE OR PUT IN HISTORY FILE
NO
918
SAVE MESSAGE IN RETRANSMISSION MEMORY FOR THIS ADDRESS

FIG.9

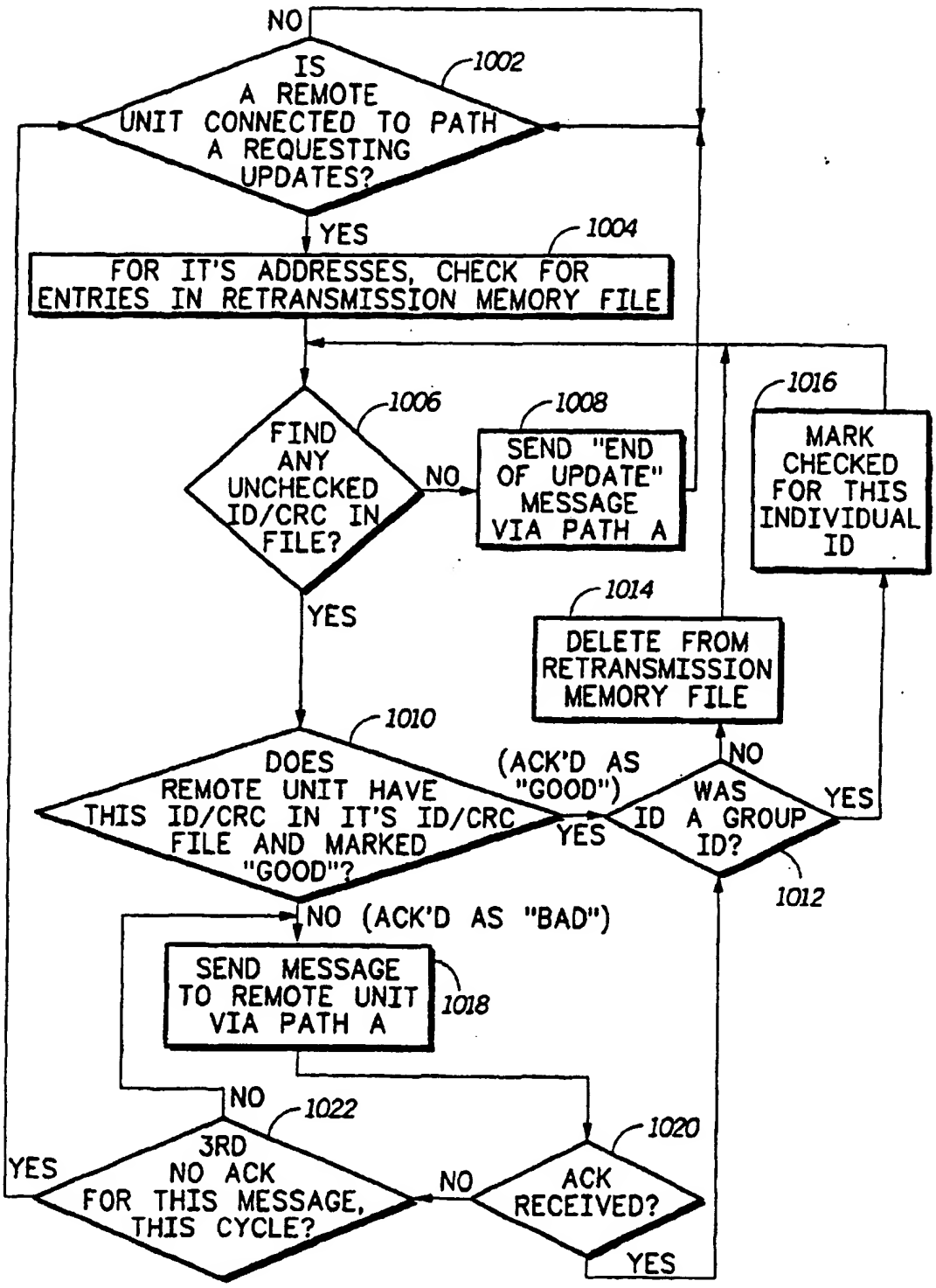

NO
IS A REMOTE UNIT CONNECTED TO PATH A REQUESTING UPDATES?
1002
YES
FOR IT'S ADDRESSES, CHECK FOR ENTRIES IN RETRANSMISSION MEMORY FILE
1004
FIND ANY UNCHECKED ID/CRC IN FILE?
1006
NO
SEND "END OF UPDATE" MESSAGE VIA PATH A
1008
YES
MARK CHECKED FOR THIS INDIVIDUAL ID
1016
DELETE FROM RETRANSMISSION MEMORY FILE
1014
DOES REMOTE UNIT HAVE THIS ID/CRC IN IT'S ID/CRC FILE AND MARKED "GOOD"?
1010
(ACK'D AS "GOOD")
YES
WAS ID A GROUP ID?
1012
NO
YES
NO (ACK'D AS "BAD")
SEND MESSAGE TO REMOTE UNIT VIA PATH A
1018
NO
3RD NO ACK FOR THIS MESSAGE, THIS CYCLE?
1022
YES
NO
ACK RECEIVED?
1020
YES

FIG.10

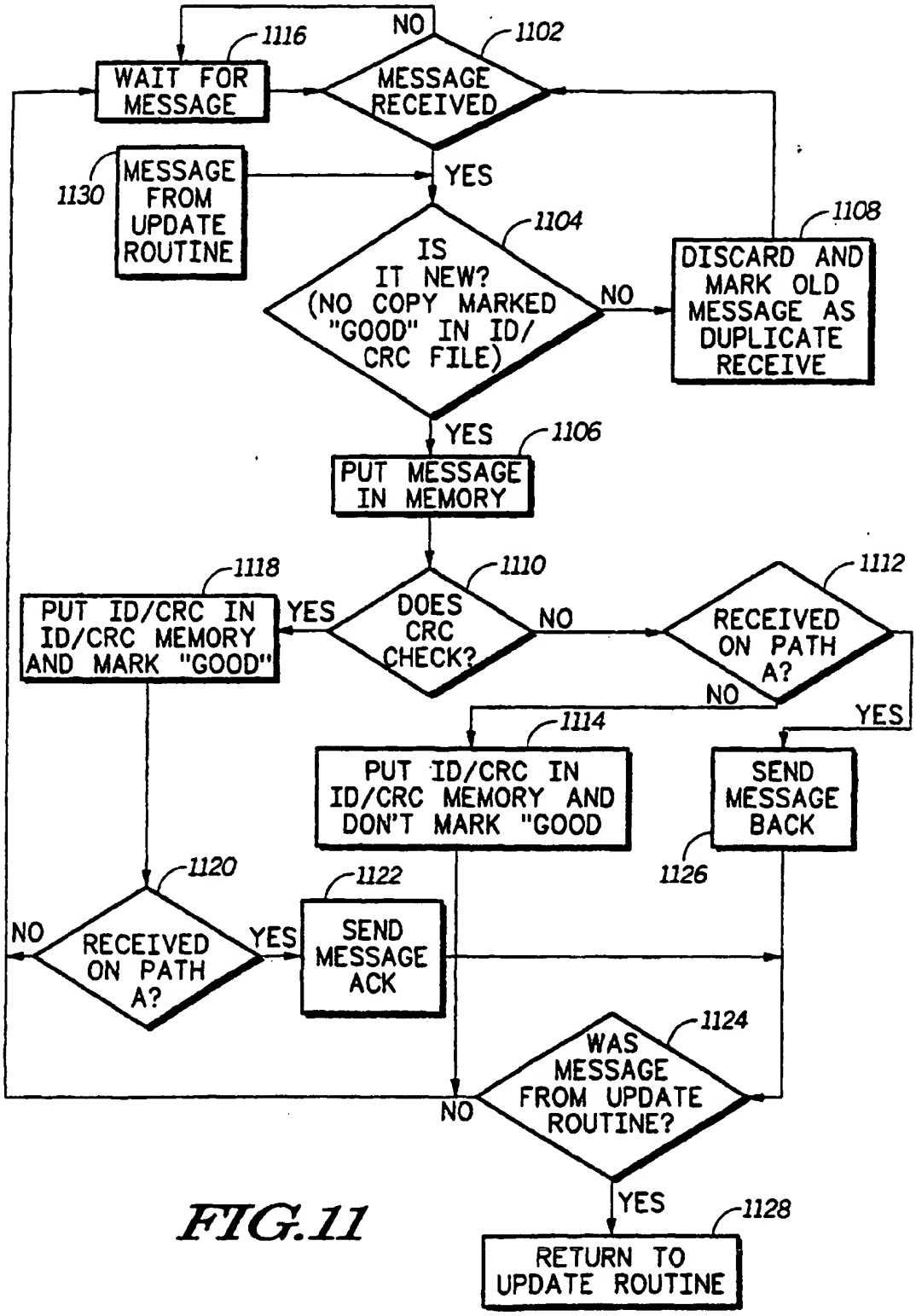

WAIT FOR MESSAGE
1116
NO
MESSAGE RECEIVED
1102
YES
MESSAGE FROM UPDATE ROUTINE
1130
IS IT NEW? (NO COPY MARKED "GOOD" IN ID/CRC FILE)
1104
NO
DISCARD AND MARK OLD MESSAGE AS DUPLICATE RECEIVE
1108
YES
PUT MESSAGE IN MEMORY
1106
DOES CRC CHECK?
1110
YES
PUT ID/CRC IN ID/CRC MEMORY AND MARK "GOOD"
1118
NO
RECEIVED ON PATH A?
1112
NO
YES
PUT ID/CRC IN ID/CRC MEMORY AND DON'T MARK "GOOD
1114
SEND MESSAGE BACK
1126
RECEIVED ON PATH A?
1120
NO
YES
SEND MESSAGE ACK
1122
WAS MESSAGE FROM UPDATE ROUTINE?
1124
NO
YES
RETURN TO UPDATE ROUTINE
1128

FIG.11

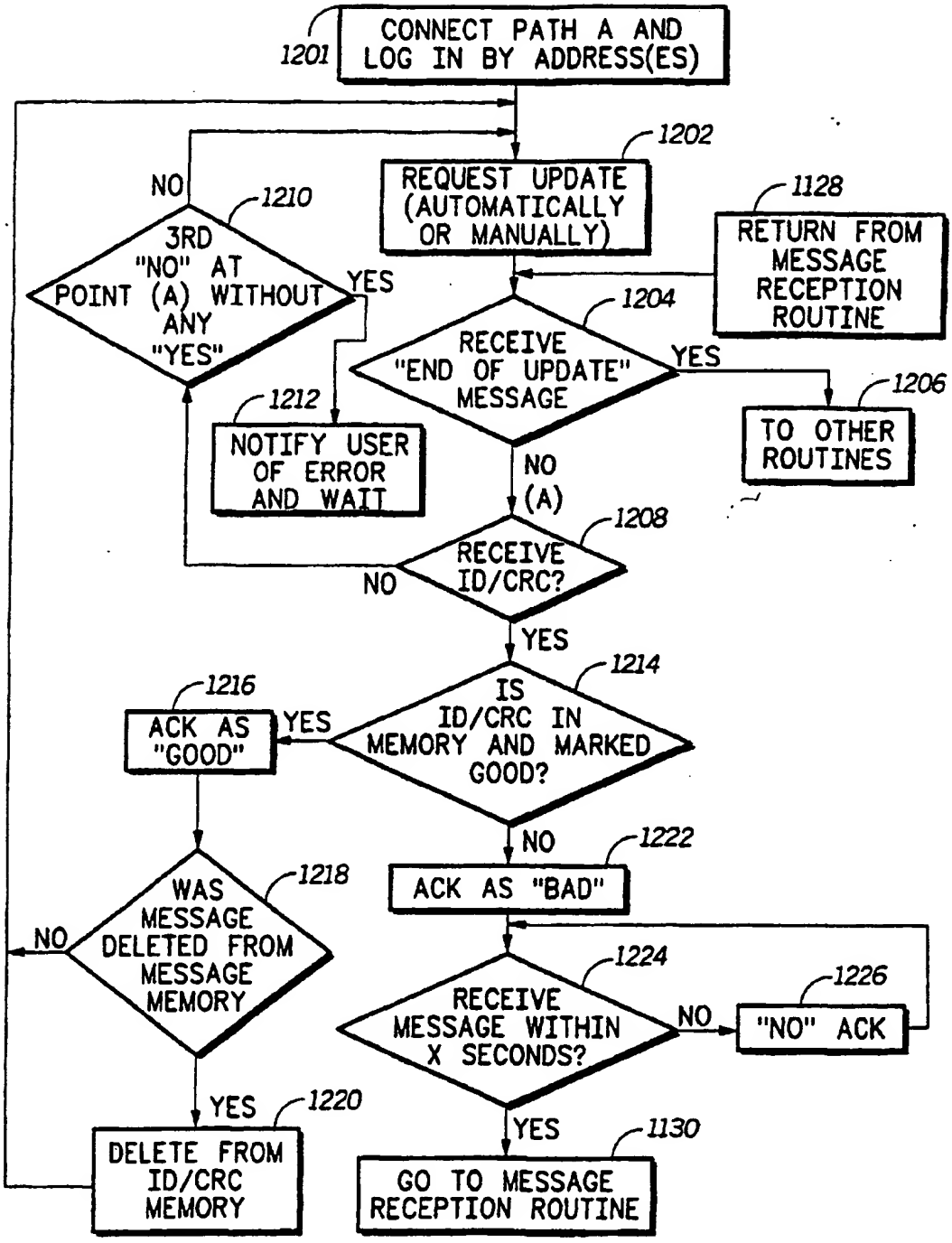

1201
CONNECT PATH A AND LOG IN BY ADDRESS(ES)
1202
REQUEST UPDATE (AUTOMATICALLY OR MANUALLY)
1128
RETURN FROM MESSAGE RECEPTION ROUTINE
1204
RECEIVE "END OF UPDATE" MESSAGE
YES
1206
TO OTHER ROUTINES
NO
(A)
1208
RECEIVE ID/CRC?
NO
YES
1210
3RD "NO" AT POINT (A) WITHOUT ANY "YES"
YES
NO
1212
NOTIFY USER OF ERROR AND WAIT
1214
IS ID/CRC IN MEMORY AND MARKED GOOD?
YES
1216
ACK AS "GOOD"
NO
1222
ACK AS "BAD"
1218
WAS MESSAGE DELETED FROM MESSAGE MEMORY
NO
YES
1220
DELETE FROM ID/CRC MEMORY
1224
RECEIVE MESSAGE WITHIN X SECONDS?
NO
1226
"NO" ACK
YES
1130
GO TO MESSAGE RECEPTION ROUTINE

FIG.12

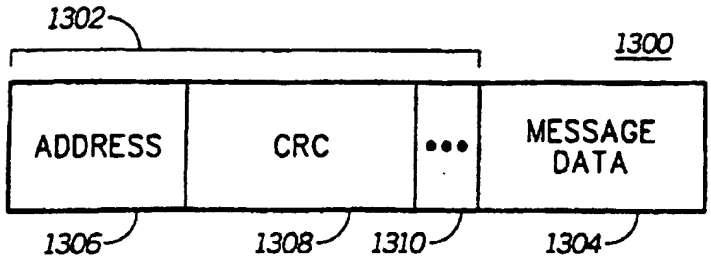

1302
1300
ADDRESS
CRC
•••
MESSAGE DATA
1306
1308
1310
1304

FIG.13

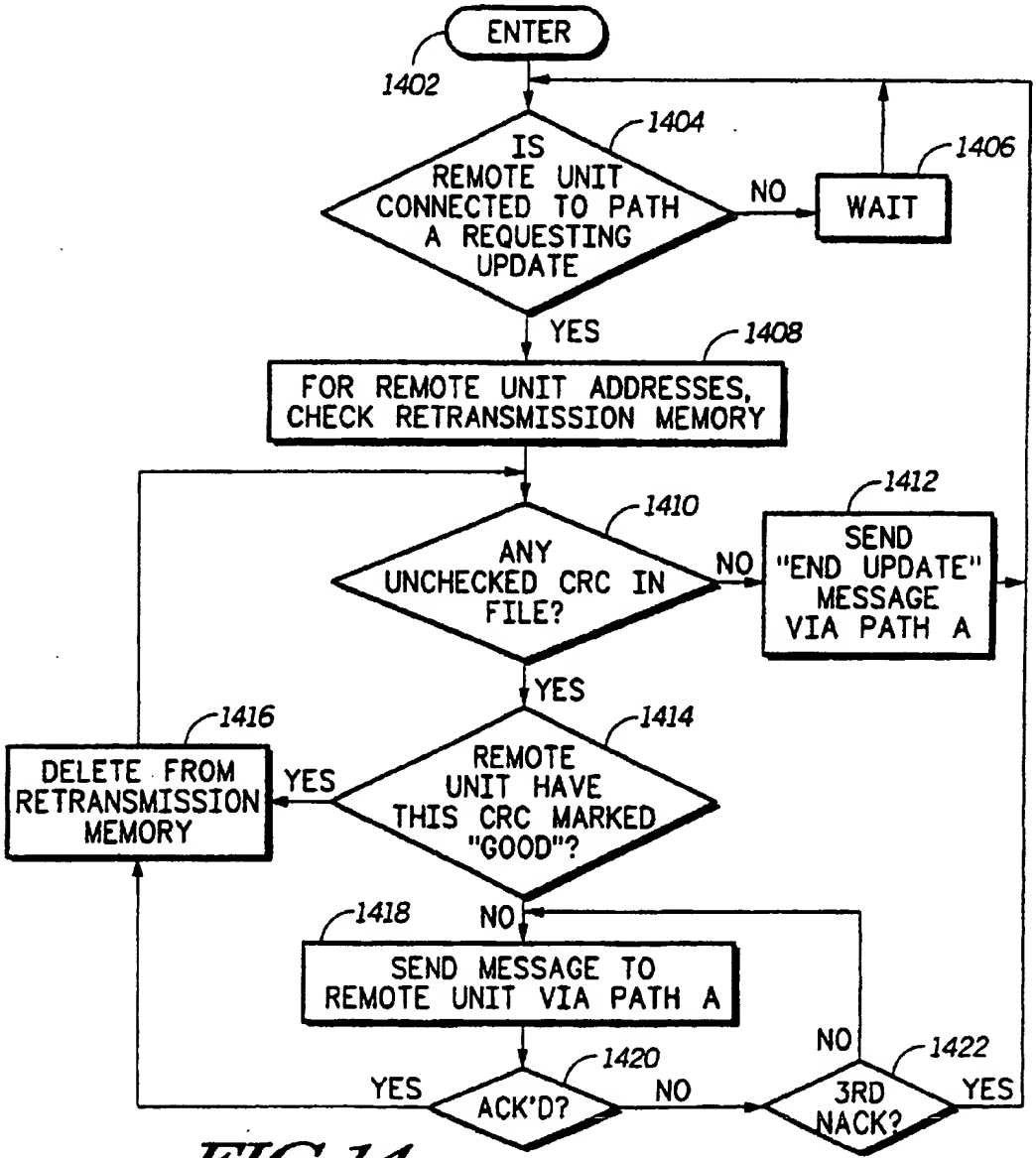

ENTER
1402
1404
IS REMOTE UNIT CONNECTED TO PATH A REQUESTING UPDATE
NO
1406
WAIT
YES
1408
FOR REMOTE UNIT ADDRESSES, CHECK RETRANSMISSION MEMORY
1410
ANY UNCHECKED CRC IN FILE?
NO
1412
SEND "END UPDATE" MESSAGE VIA PATH A
YES
1414
REMOTE UNIT HAVE THIS CRC MARKED "GOOD"?
YES
1416
DELETE FROM RETRANSMISSION MEMORY
NO
1418
SEND MESSAGE TO REMOTE UNIT VIA PATH A
1420
ACK'D?
YES
NO
NO
1422
3RD NACK?
YES

FIG.14

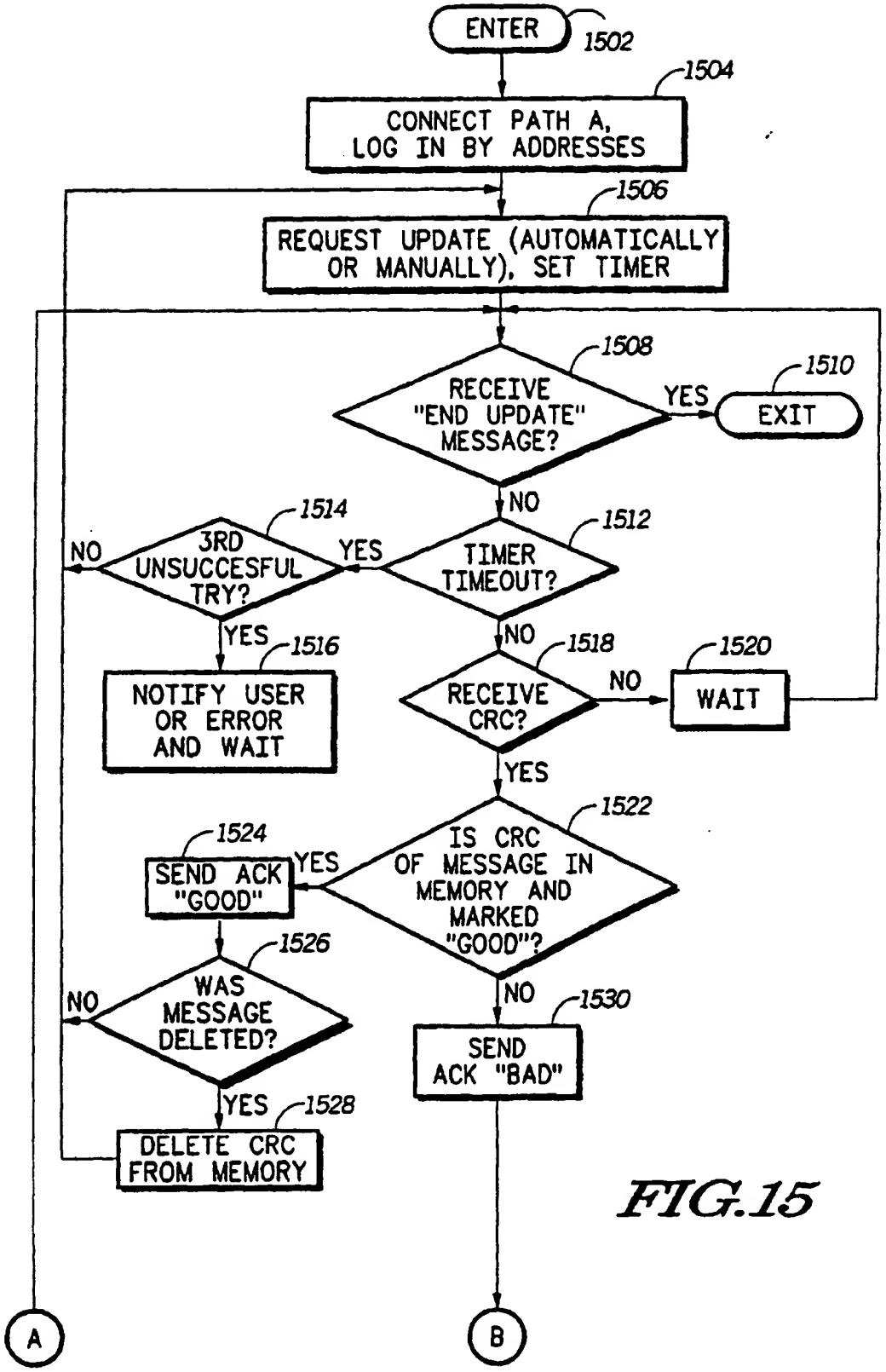

ENTER
1502
1504
CONNECT PATH A, LOG IN BY ADDRESSES
1506
REQUEST UPDATE (AUTOMATICALLY OR MANUALLY), SET TIMER
1508
RECEIVE "END UPDATE" MESSAGE?
YES
1510
EXIT
NO
1514
3RD UNSUCCESFUL TRY?
NO
YES
1512
TIMER TIMEOUT?
YES
1516
NOTIFY USER OR ERROR AND WAIT
NO
1518
RECEIVE CRC?
NO
1520
WAIT
YES
1522
IS CRC OF MESSAGE IN MEMORY AND MARKED "GOOD"?
1524
SEND ACK "GOOD"
YES
1526
WAS MESSAGE DELETED?
NO
YES
1528
DELETE CRC FROM MEMORY
NO
1530
SEND ACK "BAD"
A
B

FIG.15

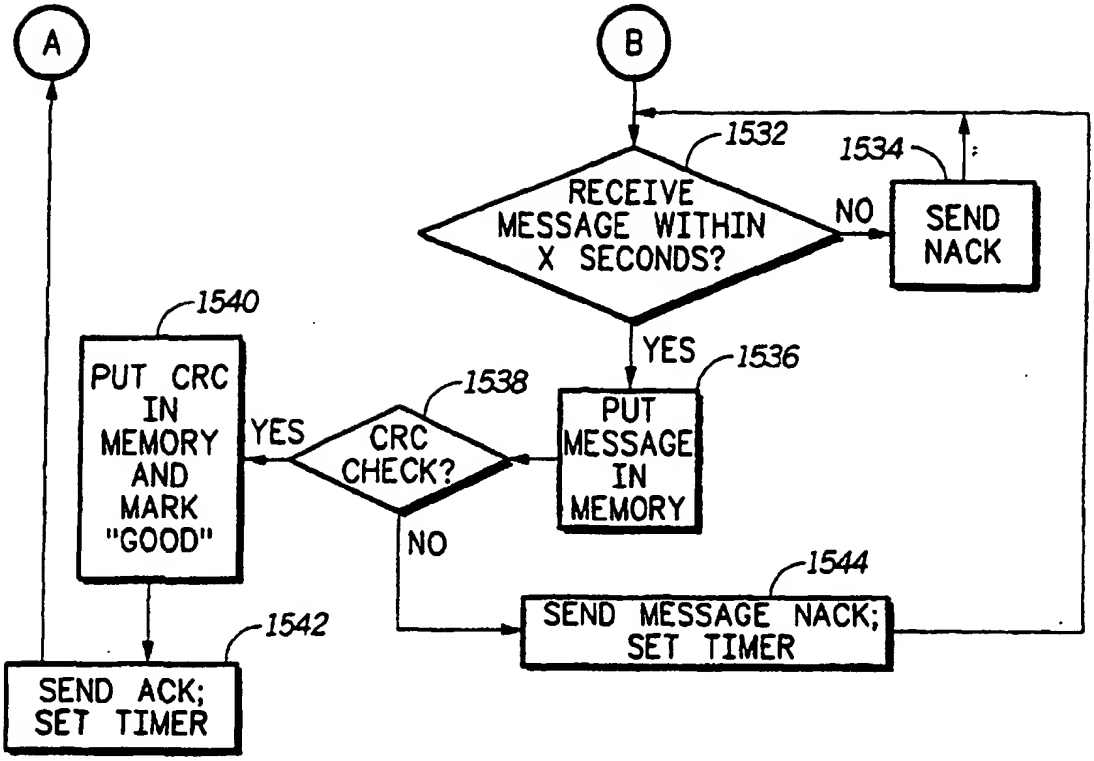

A
B
1532
RECEIVE MESSAGE WITHIN X SECONDS?
NO
1534
SEND NACK
YES
1536
PUT MESSAGE IN MEMORY
1538
CRC CHECK?
YES
1540
PUT CRC IN MEMORY AND MARK "GOOD"
NO
1544
SEND MESSAGE NACK; SET TIMER
1542
SEND ACK; SET TIMER

FIG.16